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GEMMOLOGICAL ASSOCIATION
OF GREAT BRITAIN
SAINT DUNSTAN'S HOUSE, CAREY LANE
LONDON, EC2V 8AB

GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

Saint Dunstan's House, Carey Lane, London EC2V 8AB
(By Goldsmiths' Hall) *Telephone:* **01-726 4374**

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SOME ASPECTS OF IDENTIFICATION OF KASHAN SYNTHETIC RUBIES

By ULRICH HENN, Dip.Min. and
HANS-WERNER SCHRADER, Dip.Min., F.G.A.

Institut für Edelsteinforschung, University of Mainz, W. Germany.

ABSTRACT

Synthetic rubies by Kashan are characterized by inclusions of melt residues. Cryolite was used as flux. The inclusions can be divided into four types. Even in samples looking apparently free of inclusions, these inclusions can be found by microprobe analysis (15 samples). The increased amounts of sodium found with the help of neutron activation analysis (NAA) in two analysed samples are caused by these inclusions of cryolite.

INTRODUCTION

The continual progresses and improvements of the production of synthetic gemstones need always new methods for identification against their natural counterparts, if the criteria for distinction, used up to now, are not sufficient or existent any longer.

As one can imagine, the criteria of identification of a particular synthetic gemstone are not always or totally published in order to avoid the possibility that the producer of this synthetic gemstone may modify the method of growing the crystals, for example by eliminating certain characteristic impurities.

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On the other hand facts which are typical for the method of synthesis of this material and therefore cannot be altered or be prevented, such as, for example, the alterations of the trace elements in flux-grown emeralds (Schrader, 1981, 1983), can be published. The authors of this paper will try to sum up some of the facts on the Kashan synthetic rubies now being offered in a high percentage in the market.

SYNTHESIS OF RUBIES

The development of modern synthetic rubies started after the first successful attempts with flux-fusion synthesis for emeralds. Until then only the easily perceptible synthetic rubies made by the Verneuil process were of considerable importance. Also attempts in the hydrothermal process, developed by the German chemist, Professor Dr Nacken, in the thirties, failed to arouse any commercial interest.

The first method to produce modern synthetic rubies under commercial conditions was flux-fusion synthesis by Carroll F. Chatham from San Francisco at the beginning of the sixties. Investigations proved that he added lithium-molybdates to bring down the temperature of crystallization. Some scientists (Kleber & Fehling, 1965; Arlett *et al.,* 1967; Watanabe & Sumiyoshi, 1974) have been successful in this field by using cryolite.

In 1968 the first synthetic rubies grown from cryolite melts came on the gem-market. These synthetic rubies were produced by Ardon Associates in the United States and have been offered as 'rubies grown by Kashan'.

INCLUSIONS

In spite of the addition of cryolite as crystallizer the temperature of crystallization still reached 892°C to 1041°C (Watanabe & Sumiyoshi, 1977). Therefore only melting residue and perhaps some particles of the crucible and no fluids can be detected as inclusions in the synthetic rubies by Kashan. Investigations done by microprobe analysis proved beside cryolite (Gübelin, 1982) also an alumina phase as part of these heterogeneous melting residues.

If recognizable, these melt residues are typical for synthetic rubies by Kashan. They have been found in different types:

—feathers: these feathers are familiar in their order, their torsion and their mesh-like network.

FIG. 1. Feather of melt residue inclusions in a synthetic Kashan ruby. (65 ×)

—fingerprint inclusions: this kind of inclusion was believed to be a characteristic of natural rubies, mainly from Burma, but Crowningshield (1968) and (Burch 1984) described them in Kashan synthetic rubies too.

—string of pearl-like inclusions: these isolated, threaded-looking inclusions have been seen neither in natural nor in other synthetic rubies up to now.

—comet- or hairpin-like inclusions: these inclusions have been described sometimes (Anderson, 1981; Gübelin, 1982, 1983) to be a typical mark of identification. They occur like a 'V', like rutile, or parallel, like growth striae. But they have been seen now in a fibrous marking, as known with byssolite in garnets, too.

Because all of the inclusions of these kinds are chemically identical and are formed according to the different speed of crystal growth of the host crystal, they all show the same marks of identification. These melt residues appear in brightfield illumination in the microscope nearly opaque and homogeneous, occasionally semitranslucent. In darkfield illumination the strong relief and the heterogeneous, granular character and even a typical metallic reflection are visible.

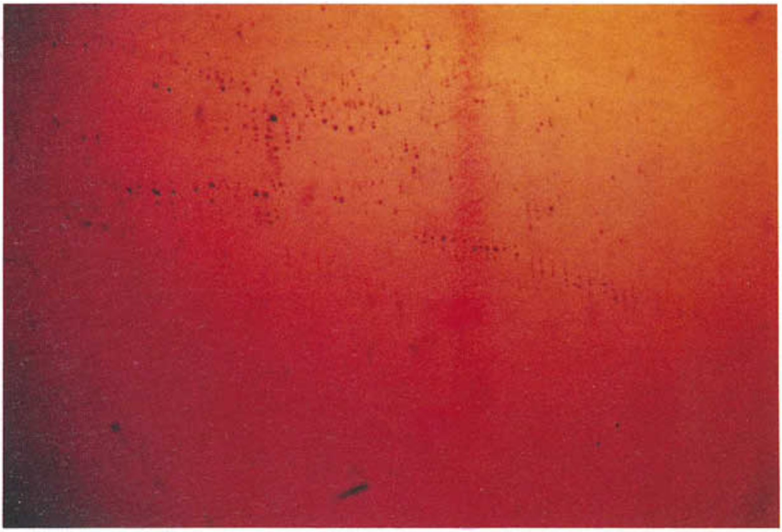

FIG. 2. String of pearl-like inclusions of melt residues in a synthetic Kashan ruby. (18 ×)

FIG 3. String of pearl-like inclusions of melt residues in a synthetic Kashan ruby. (50 ×)

FIG. 4. Comet- or hairpin-like melt residue inclusions in a synthetic Kashan ruby. (28 ×)

FIG. 5. Comet- or hairpin-like melt residue inclusions in a synthetic Kashan ruby. (50 ×)

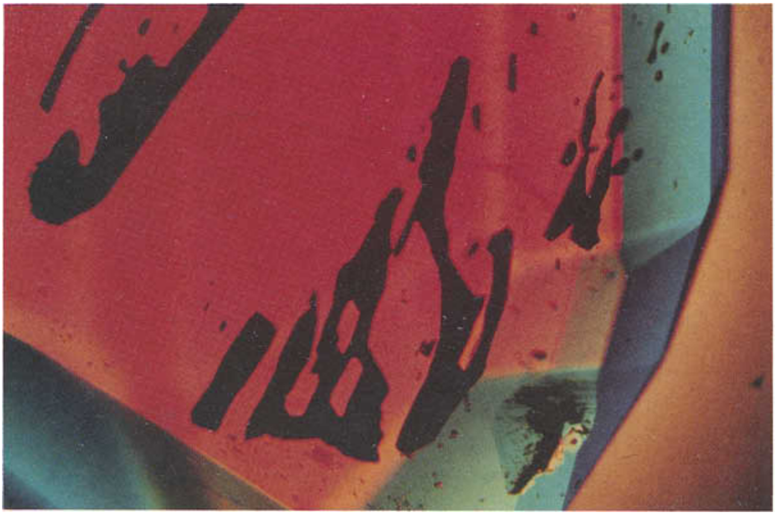

FIG. 6. Melt residues as inclusions in a synthetic Kashan ruby. (28 ×, brightfield illumination)

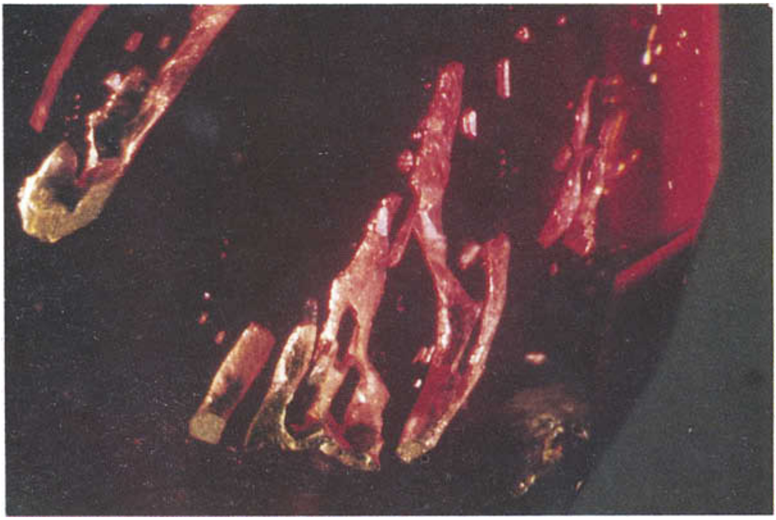

FIG. 7. Melt residues as inclusions in a synthetic Kashan ruby. (28 ×, darkfield illumination)

Unlike a fluid inclusion, the *whole* melt-residue inclusion in flux-grown synthetics may be seen in a reflecting position if moved under the microscope.

CHEMICAL RESULTS

Clearly the identification of gemstones free of any inclusion proves to be difficult. Because of the good results with the analysis of trace elements for distinction (Schneider, 1977; Schrader, 1981, 1983; Hänni, 1982; Kuhlmann, 1983) the Kashan synthetic rubies were determined by neutron activation analysis. From the results, shown in Table 1, a distinctly increased sodium content in Kashan synthetics compared to natural rubies from different occurrences is found.

Apparently these results were not comparable with those of the electron microscope analysis. But the essentially better possibilities of magnification with the microprobe analysis in comparison with the normal (gem) microscope showed that none of the tested synthetic rubies were free of inclusions using a suitable magnification and that always in a statistical distribution submicroscopic inclusions of melt residue have been recognized.

Caused by the system of working, neutron activation analysis reveals the chemistry of the whole sample, and the sodium contents coming from the cryolite inclusions became part of the analysis. With the microprobe analysis it was possible, but only under a higher limit of detection, to find and to analyse sectors sufficiently free of inclusions. These results show no, or hardly increased, sodium contents at the surface.

But, for distinction from natural rubies, in all Kashan synthetic rubies tested very small inclusions of cryolite have been found and analysed. Therefore microprobe analysis makes possible the separation of Kashan synthetic rubies which appear to be free of inclusions. Increased sodium contents of the samples point to the existence of inclusions of cryolite caused by the flux method for synthesis.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to the firm of Gebrüder Goerlitz, Idar-Oberstein, for kindly placing the rubies at their disposal.

TABLE 1

Neutron activation analyses of natural and synthetic rubies (in ppm)

	1	2	3*	4*	5*	6*	7*	8*	9*	10*
Na	410	2631	59	60	60	58	60	69	78	105
Cr	1296	329	4930	2884	957	3125	6484	1858	2297	1436
Mn	0.9	1	3	0.5	0.1	0.1	0.3	0.1	12	0.7
Fe	11	—	<50	3428	86	2278	2232	272	188	818
Ga	—	.5	1	23	108	29	22	296	145	72

sample No. 1, 2: Kashan synthetic ruby (flux-grown)
sample No. 3 : Chatham synthetic ruby (flux-grown)
sample No. 4 : Ruby from Burma
sample No. 5 : Ruby from Sri Lanka
sample No. 6 : Ruby from Thailand
sample No. 7 : Ruby from Tanzania
sample No. 8 : Ruby from Kenya
sample No. 9 : Ruby from Pakistan
sample No.10 : Ruby from Madagascar

*Analyses from Schneider, 1977.

TABLE 2

Electron microprobe analyses of Kashan synthetic rubies (in wt %)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Al_2O_3	96.93	96.64	96.73	95.63	94.79	94.92	95.33	95.86	96.24	95.19	95.56	95.59	96.82	95.64	95.46
Na_2O	0.01	0.01	0.01	0.01	0.01	0.02	n.d.	0.01	n.d.	n.d.	0.01	0.01	n.d.	n.d.	n.d.
SiO_2	n.d.	0.02	0.01	0.03	n.d.	0.01	0.02	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.03
V_2O_5	0.01	0.01	0.08	0.04	0.03	0.02	0.03	0.02	0.02	0.05	0.05	0.05	0.03	0.06	0.06
Cr_2O_3	0.06	0.10	0.10	0.30	0.22	0.26	0.70	0.13	0.32	0.58	0.43	0.55	0.12	1.50	1.10
MnO	0.03	0.01	0.01	n.d.	0.01	0.04	0.02	0.01	0.01	0.07	n.d.	0.02	0.01	0.02	0.02
FeO	0.03	0.07	0.03	0.03	0.03	0.05	0.03	0.01	0.06	0.03	0.02	0.01	0.01	0.03	0.01
CoO	0.01	0.01	0.02	n.d.	n.d.	0.01	0.01	n.d.	n.d.	0.01	0.02	0.01	0.01	0.02	0.01
NiO	0.02	0.03	0.03	0.01	0.01	0.02	0.02	0.02	n.d.	0.02	n.d.	0.04	0.01	0.05	0.01
MgO	0.01	0.01	n.d.	n.d.	0.01	n.d.	n.d.	0.01	0.01	n.d.	0.01	0.01	0.01	0.01	n.d.
Total	97.11	96.91	97.02	96.05	95.11	95.35	96.16	96.09	96.69	95.96	96.09	96.30	97.03	97.34	96.71

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[Manuscript received 20th July, 1984]

POLYSYNTHETIC TWIN LAMELLAE IN SYNTHETIC VERNEUIL SAPPHIRE

By J. M. DUROC-DANNER, F.G.A., G.G.

Geneva, Switzerland.

INTRODUCTION

The writer was intrigued recently, by a 2.35 ct 'native' brilliant-cut stone whose unnaturally intense colour, although attractive, looked not quite right but similar to that of treated sapphires. Since some genuine and synthetic sapphires are known to have their colour enhanced by treatment(1) and since of all the characteristics that permit distinction colour is the least dependable, the stone had to be tested.

EXAMINATION UNDER 10× LENS

Except for a few straight and parallel twinning lines, the stone looked particularly clean. Careful inspection of the girdle did not reveal the characteristic pockmarked 'double girdle' indicating possible heat treatment.(1) The colour, while the stone was immersed in methylene iodide, appeared to be concentrated near the surface, and this is an indication of possible treatment.(1)

ABSORPTION SPECTRUM

The diagnostic iron absorption line at approximately 4500 Å was missing when the stone was observed visually both in transmitted and scattered light on a Gem Beck spectroscope unit.

FLUORESCENCE

With the GAAJ Multispec combined LW/SW unit, under UV 2536 Å and UV 3650 Å, the stone remained inert.

EXAMINATION UNDER THE MICROSCOPE

The stone immersed in methylene iodide was observed on a horizontal Eickhorst stand between crossed polaroids coupled to a Gemolite Bausch & Lomb Mark V microscope, and revealed very easily the straight twinning striations that were observed with the 10× lens (Figures 1, 2, 3).

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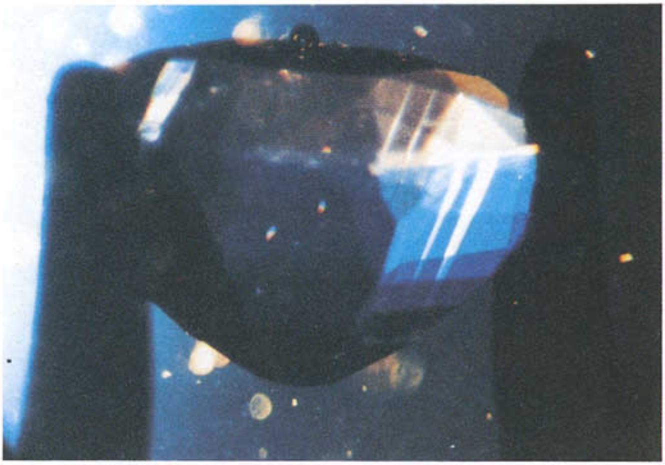

FIG. 1. Side view

FIG. 2. Pavilion view

FIGS 1, 2. Straight twinning striations as they appeared under the microscope when the stone was immersed in methylene iodide.

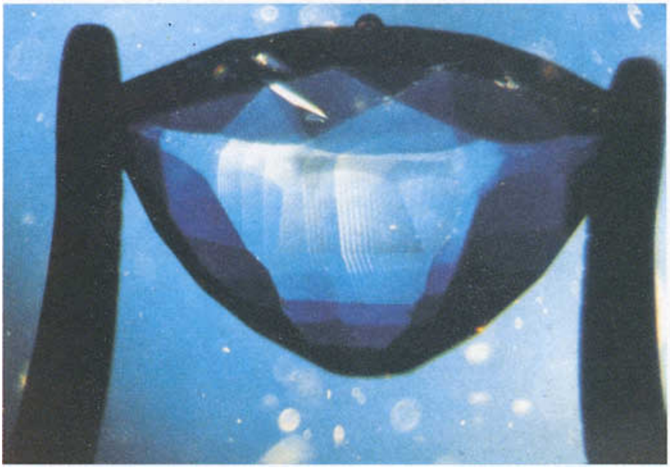

FIG. 3. Polysynthetic twin lamellae in Verneuil synthetic with interference rings along the twin planes as seen while the stone was immersed in methylene iodide between crossed polaroids. (15 ×)

FIG. 4. 'Plato striation' obtained parallel to the c axis while the stone was immersed in methylene iodide between crossed polaroids in their dark position. (15 ×)

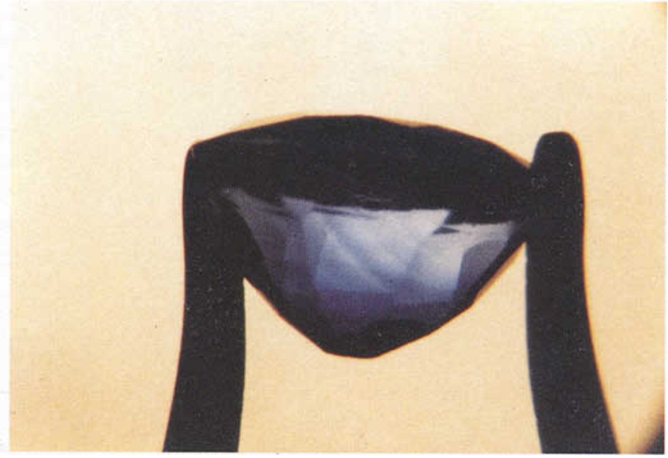

FIG. 5. Curved colour-bands made visible when the stone was immersed in methylene iodide with diffused light source. (15 ×)

It should be noted here that with crystal inclusions, healing planes filled with liquid drops and zonal effects in straight lines, polysynthetic twin lamellae are regarded as one of the characteristics of genuine corundum.* This twinning occurs frequently in ruby, but less so in sapphire.(2) They are also seen, but infrequently and rather as an exception, in their respective Verneuil synthetics.(3,4,5,6) Since this particular sapphire showed no other characteristic but these twinning lines, it was decided while still under crossed polaroids, and in their dark position, to locate the direction of the optic axis of the stone, and try to obtain the lozenge-shaped pattern which is originated by two sets of straight twinning lamellae intersecting each other at 120° and 60° and known as the 'Plato striation'.(5)

The Plato striation effect which betrays 'Verneuil synthetics' was obtained as can be seen in Figure 4. As for the curved coloured bands, these were seen with difficulty, only when the stone was immersed in methylene iodide and the light source masked by a tissue paper (Figure 5).

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*Syntheses different from Verneuil's (Knischka, Chatham, Kashan, . . .) can show 'similar' characteristics to those mentioned for natural corundum, and this has to be taken into account if errors of judgement are to be avoided.[illegible]

DISCUSSION

The origin of the 'real' polysynthetic twinning must be due to a different phenomenon from the Plato twinning since it does not follow the same direction as can be seen in Figures.1, 2, 3.

These polysynthetic twin lamellae seem to be found in planes slightly inclined to the optic axis. Since this faceted stone does not show crystalline faces, it would be hazardous to guess the precise orientation of the plane containing these twin lamellae. Up to now, all Verneuil synthetics tested by the writer have shown a positive Plato striation, while only this particular synthetic sapphire showed 'real' polysynthetic twinning very similar to that found in natural corundum. Therefore, great care should be taken to obtain either the coloured curves or a Plato striation when such a stone is encountered, if costly mistakes are to be avoided.

Other synthetics, like Kniscka, Chatham, Kashan, . . . and the Ramaura flux ruby, are said to be devoid of this form of 'true' twinning which can be followed deeply inside the gem(7,8,9) (Figure 3).

As for the colour, it was not possible for the writer to test the stone's reaction to re-polishing, but since it did not show the usual characteristic chalky bluish-green glow under short-wave ultraviolet light, and the colour seemed to be concentrated near the surface, it could possibly have been surface diffusion treated.

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A 'THREE-PHASE INCLUSION' IN AN EMERALD FROM SOUTH AFRICA

By HANS-WERNER SCHRADER, Dip.Min., F.G.A.

Institut für Edelsteinforschung, University of Mainz, W.Germany

Surprises are still possible in specimens from well known occurrences. Some little time ago in a cabochon emerald an unexpected inclusion was found. The occurrence of the emerald, said to be the Cobra Mine* in South Africa, was recognizable by the totality of the inclusions, even though one of the inclusions observed was unexpected and unusual in a South African emerald.

A so called 'three-phase inclusion' was found, such as has been described mainly for Colombian emeralds up to now. Such an inclusion contains, despite its slightly misleading designation (as Gübelin has pointed out), not unconditionally three phases of one substance in the physical-chemical sense, but three substances in different states of aggregation. That means that this inclusion contains the three different substances within it in the three different states of aggregation respectively, namely the gaseous, the liquid and the solid (crystalline) states. In a long, needle-like cavity, a primary inclusion, a gas bubble is included in a liquid (as in a spirit level), together with a cubic crystal.

This observation is unusual in so far as the origin of such inclusions seems to be tied to hydrothermal emerald occurrences. But the South African deposits are described as being of a pegmatitic-pneumatolytic kind and are marked by mica plates, as also in this case.

Although the author remembers a similar observation some years ago, it has not been reported yet, so this seems to be the famous 'exception that proves the rule'. But this exception is not inconceivable, for there are fluent transitions from one phase of the crystallization of magma to another.

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*See Webster's *Gems*, 4th edn (revd B. W. Anderson), 1983, p.110.—Ed

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FIG. 1. Needle-like cavity with a liquid, a gas bubble and a crystal, forming a 'three-phase-inclusion' in a South African emerald (400 ×)

NOTE ON INCLUSIONS IN DIOPSIDE FROM ALA, PIEDMONT, ITALY

By BRIAN JACKSON, F.G.A.

The Royal Scottish Museum, Edinburgh

A slightly yellowish green crystal of diopside from an old collection and clearly labelled as coming from Ala, Piedmont, Italy, was recently sent for faceting. The cut gemstone proved to have, in addition to the normal rod like inclusions seen in diopside, inclusions of a type not previously observed in diopside by the author nor apparently described in the literature. The latter occur as extensive curved swirls and veils (Figure 1) which mainly consist of two sets of multiple small parallel two- and three-phase, predominantly euhedral, negative inclusions (Figure 2). Of these sets, one orientation is dominant, the others' presence being minor or in some cases absent altogether. The size of these small inclusions is variable, ranging from 100 to 10 μm. The inclusions are almost certainly pseudosecondary in origin, that is, they are healing fissures formed in the crystal during its growth in the parent fluid. This is deduced from observed necking-down features (Figure 3), connecting tubes and trails (Figure 4), and in addition the orientations of the negative crystals follow crystallographic directions and there is optical continuity, under crossed polars, between the host and the immediate surrounds.

Using a freezing microscope stage, a study of the fluid inclusions was made. A specially prepared sample was frozen to −70°C and then slowly brought up to room temperature. At −37°C the gas bubble contracted and all the liquid froze into a coarse-grained solid. At −36°C partial melting occurred along the grain boundaries and cracks began to appear. This condition persisted until −8°C when further melting occurred. At −1.9°C all the frozen liquid phases had melted. The temperatures at which phase changes took place indicated that the liquid was a saturated mixed saline brine, the major salt being NaCl with only a very minor amount of $MgCl_2$ (Hollister & Crawford, 1981). The isotropic cubic daughter-crystals in the three-phase inclusions are therefore thought to be halite. It was interesting to note that some of the two-phase

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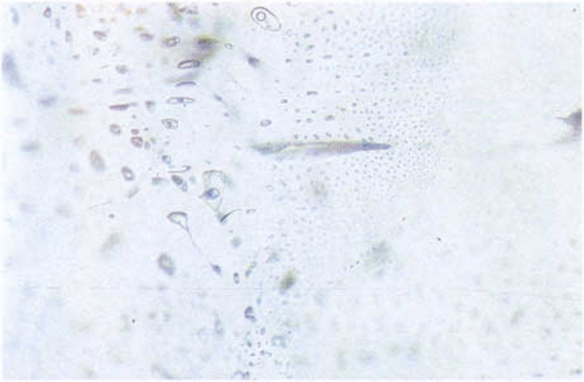

FIG. 1. Curved swirls and veils.

FIG. 2. Parallel alignment of two- and three-phase negative inclusions.

FIG. 3. Necking-down feature.

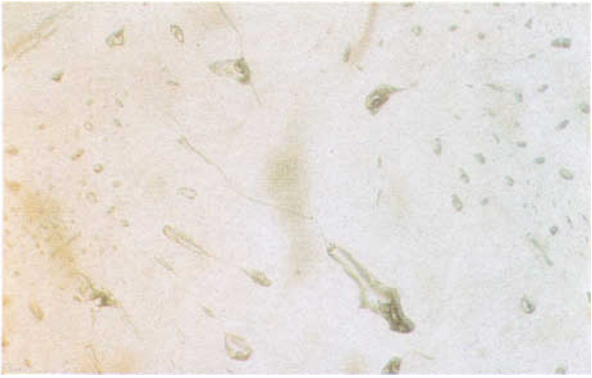

FIG. 4. Connecting tubes and trails.

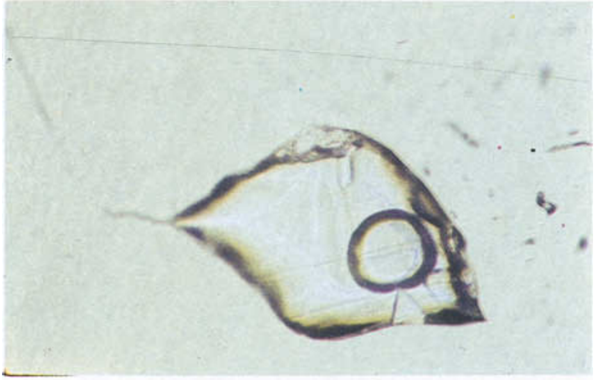

FIG. 5. Some unidentified daughter crystals.

FIG. 6. 'Bearding' lining and negative inclusion.

inclusions when frozen resulted in the nucleation of the stable phase; NaCl crystals. This is due to the withdrawal of water from the solution, thus increasing the degree of supersaturation (Roedder, 1972). Once nucleated, the solid phase persisted.

Several types of unidentified anisotropic microlites are also present in some negative inclusions. These take the form of triangular and prismatic crystals (Figure 5). There is also an unidentified fibrous mineral that forms 'bearding' around the inside of some of the negative inclusions (Figure 6).

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[*Manuscript received 8th August, 1984*]

SPECTROPHOTOMETRIC MEASUREMENTS OF FACETED RUBIES

By Dr ARUN BANERJEE, JOACHIM HIMMER, Dip. Min., and HANS-WERNER SCHRADER, Dip. Min., F.G.A.

Institut für Edelsteinforschung, University of Mainz, West Germany.

Spectrophotometric measurements have been proved to be useful for the identification and distinction of natural and synthetic gemstones (Schmetzer & Bank, 1980; Bosshart, 1982). As most of

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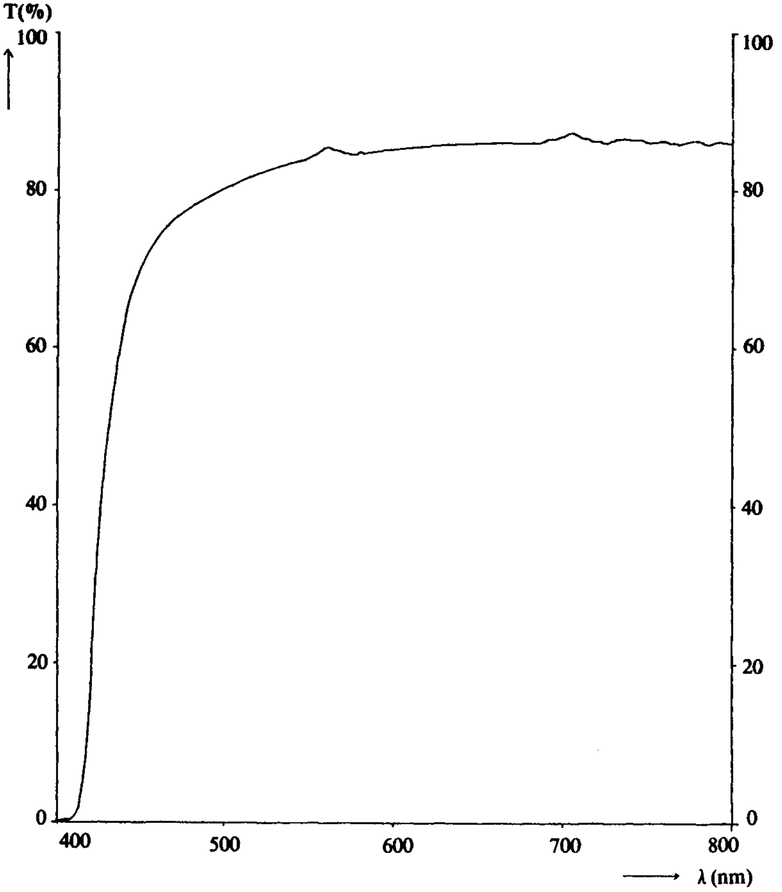

FIG. 1. Transmission diagram of methylene iodide.

the spectral measurements are carried out on thin polished platelets, the results achieved cannot be easily reproduced in the case of faceted gemstones (due to scattering and multiple reflection). The purpose of this short communication is to show how the spectrophotometric method can be applied to faceted gemstones.

In order to eliminate the 'disturbing' factors due to scattering, reflection and refraction, an immersion method has been used and thus the ray of transmitted light passing through the gemstone could be directly measured. The method has been sucessfully tried on faceted rubies.

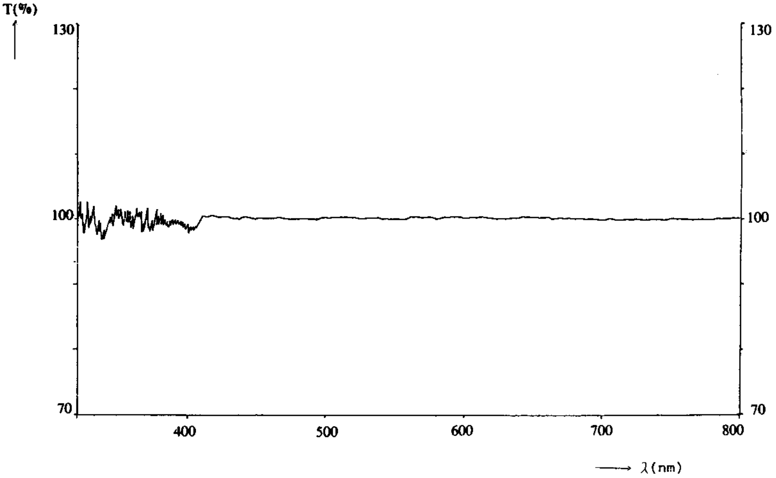

FIG. 2. Transmission diagram after the auto-zero cycle.

The rubies were fixed in a sample holder in an immersion cell filled with methylene iodide (diiodomethane): see Figure 1. The immersion cell was placed in the path of the ray of light. The measurement was performed with a double beam UV-VIS-spectrophotometer (Perkin Elmer 551 S) in the wavelength range from 400 to 800 nm. The colour of the immersion liquid was compensated for by an identical immersion cell filled with methylene iodide placed in the path of the reference beam and by the auto-zero of the spectrophotometer. Figure 2 shows the horizontal transmission curve of the immersion cell filled with

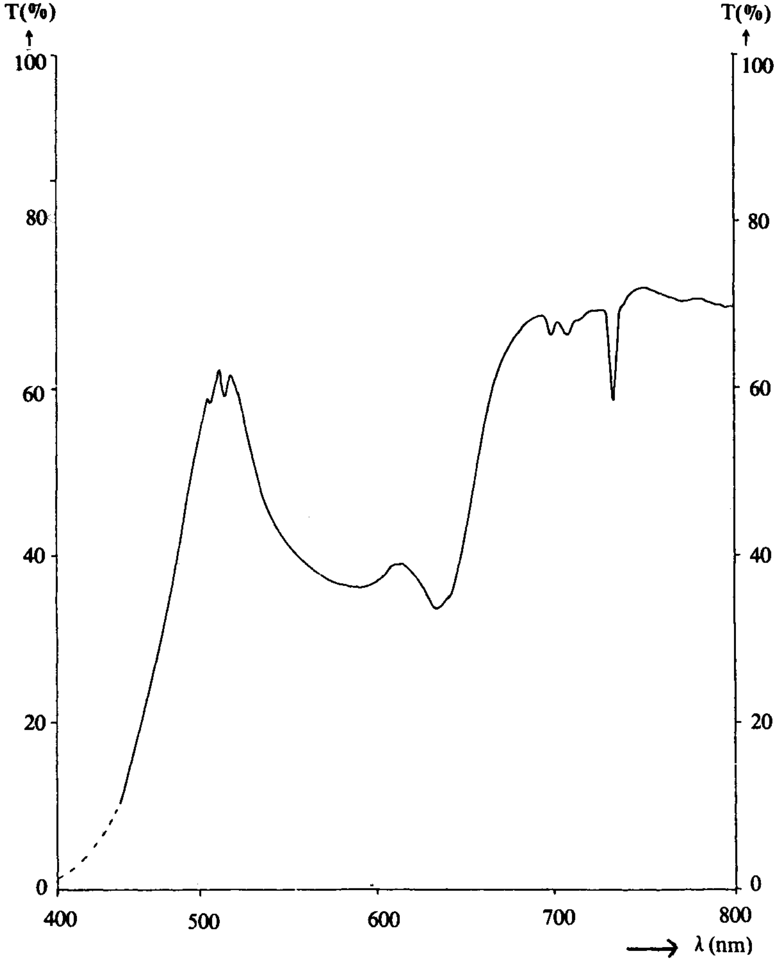

FIG. 3. Transmission diagram of a Burma ruby.

methylene iodide and without any sample after auto-zero cycle. Due to the low UV-transmission of methylene iodide no measurements could be done in the UV. Figures 3 and 4 show the transmittance curves of two rubies.

It is possible to obtain transmission measurements for other gemstones by this method.

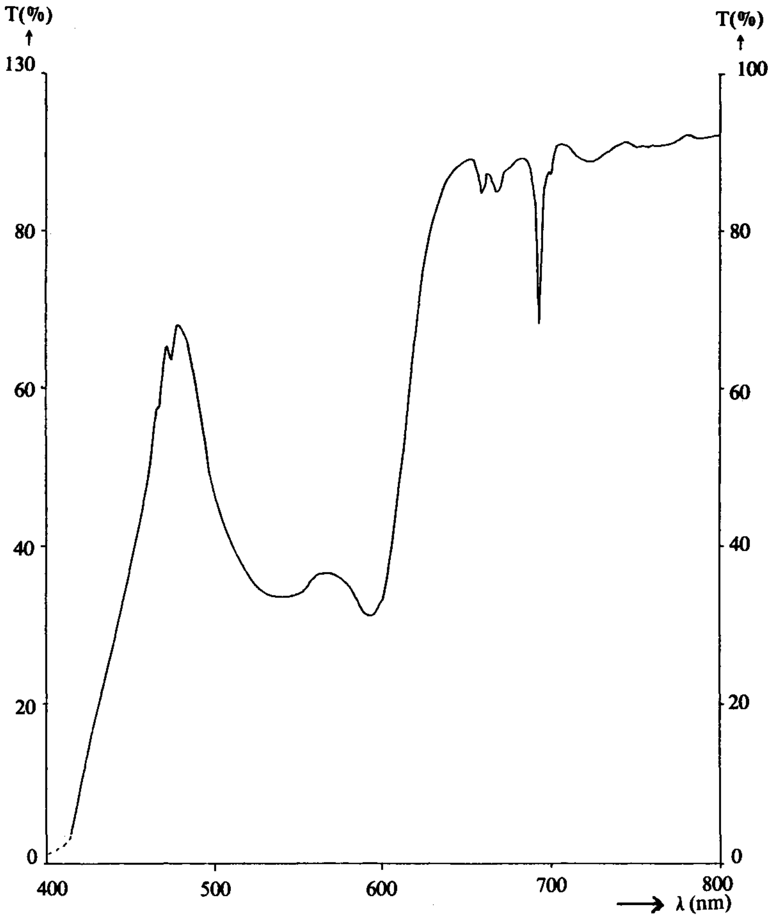

FIG. 4. Transmission diagram of a Siam ruby.

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ZINCIAN TAAFFEITE FROM SRI LANKA

By Dr KARL SCHMETZER and Prof. Dr HERMANN BANK, F.G.A.*†

*Institute of Mineralogy and Petrography, University of Heidelberg, West Germany.
†Idar-Oberstein, West Germany.

ABSTRACT

Zinc-bearing taaffeite from Sri Lanka with refractive indices of n_e 1.726, n_o 1.730, and density of 3.71 g/cm³ is described. The gemstone contains an extraordinarily high zinc content of 4.66% ZnO; the idealized chemical formula of the sample is $Be(Mg, Zn, Fe)_3Al_8O_{16}$ with Mg>Zn, Fe. The reddish-violet colour of the specimen is caused by certain amounts of iron and chromium.

Taaffeite was first described by Anderson *et al.* (1951), and at the time of the original description, only two cut stones of the gem mineral were known, most probably originating from the alluvial gem deposits of Sri Lanka. Until 1974, only two additional cut taaffeites became available; however, Sri Lanka as the most probable origin of the gems was confirmed. During a reinvestigation of the crystal chemistry and structure of the taaffeite group consisting of the minerals taaffeite, musgravite and pehrmanite, 14 cut gemstones and one small fragment of rough taaffeite from Sri Lanka were available to one of the authors for investigation in 1981 and 1982, but about 20 or even more cut taaffeites were known at that time (Schmetzer, 1983a, b, c; Nuber & Schmetzer, 1983). Until now, the authors have investigated more than 50 cut taaffeites, and more than 100 stones are known to be preserved in public or private collections or have appeared in the gem trade. At present, taaffeite from Sri Lanka is still considered as a rare gemstone; taaffeite, however, is no longer one of the rarest gem materials. Recently, one sample of rough taaffeite of gem quality was mentioned. This stone originated from Burma, probably from the Mogok region. In addition, small fragments of rough taaffeite were described from different localities such as U.S.S.R., China, and Australia (*cf.* Schmetzer, 1983a, b, c; Spengler, 1983). These taaffeites were very small and not of gemstone quality and/or size.

Taaffeite is hexagonal with unit cell dimensions of a_o 5.68, c_o 18.3 Å, and space group $P6_3mc$. Taaffeite from Sri Lanka reveals iron and zinc contents between 0.38 and 2.00% FeO and

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up to 0.66% ZnO, corresponding to a chemical formula of Be(Mg, Fe, Zn)$_3$Al$_8$O$_{16}$ with Mg>Fe and Mg≫Zn. The refractive indices, double refraction and density vary between n_e 1.717-1.720, n_o 1.721-1.724, Δn 0.004-0.005, and D 3.59-3.62 g/cm^3, respectively. The data of the Burmese gem taaffeite were given as n_e 1.716, n_o 1.720, D 3.59 g/cm^3 by Spengler (1983). Taaffeites from China and U.S.S.R. were found to contain distinct amounts of ZnO (1.89-4.27%) and MnO (0.09-3.03%). According to their somewhat higher manganese and zinc contents, the refractive indices of taaffeite from U.S.S.R. and China were found to be higher compared with the optical data of taaffeites from Sri Lanka.

In general, taaffeites of gem quality from Sri Lanka with FeO contents of about 1-2 wt% are blue or bluish-violet in colour. Some very light, almost colourless specimens with smaller iron contents (<1 wt%) are also known. Only one cut crystal of the red variety of taaffeite with chromium contents of 0.24 wt% Cr_2O_3 and vanadium contents of 0.15 wt% V_2O_3 is described, and some rose-coloured or pinkish taaffeites with smaller chromium and vanadium contents are also known. In summary, the colour of gem taaffeites from Sri Lanka is due to various amounts of iron, chromium and vanadium, and the absorption spectra of gem taaffeites are almost identical with the spectra of iron and chromium containing bluish-violet and red gem spinels (Schmetzer, 1983a).

FIG. 1. Zincian taaffeite from Sri Lanka. Size of the sample approx. 6 × 7mm.
(Photo by O. Medenbach, Bochum).

The cut taaffeite of 1.25 ct which is described in this paper (Figure 1) has extraordinarily high refractive indices of n_e 1.726, n_o 1.730, which first drew the attention of one of the authors to the stone. The optical data were found to lie still within the range of refractive indices of taaffeites from different localities; however, the refractive indices mentioned above, are not yet known at present for taaffeites from Sri Lanka. The colour of the sample is an intense reddish-violet, which also is unusual for taaffeites from Sri Lanka.

TABLE 1. Chemical and physical properties of zincian taaffeite from Sri Lanka.

Microprobe analysis (wt%)		cations calculated to O = 16		
BeO	4.40*	Be	1.003	
ZnO	4.66	Zn	0.328	2.997
FeO†	1.88	Fe	0.150	
MnO	0.06	Mn	0.005	
MgO	17.69	Mg	2.514	
Al_2O_3	71.10	Al	7.989	8.000
Cr_2O_3	0.15	Cr	0.011	
Σ	99.94			

*assumed from Schmetzer (1983a) †total iron as FeO

optical properties	n_e 1.726(1)
	n_o 1.730(1)
	Δn 0.004
density	D 3.71(2)g/cm^3

Physical and optical properties of the gemstone from Sri Lanka are presented in Table 1. The taaffeite sample was found to contain a distinct zinc content of 4.66% ZnO, which so far was not found in taaffeites from this country. The extraordinarily high refractive indices and density of the specimen are due to the unusual composition of the sample, i.e., the physical data are strongly influenced by the zinc content of the gemstone. The absorption spectrum of the taaffeite is explained by a superposition of the pure iron spectrum, which is known in detail from ordinary bluish-violet taaffeites, and the almost pure chromium spectrum, which is available to the authors from the investigation of the only known red sample with 0.24 wt% Cr_2O_3 and 0.15 wt% V_2O_3 (*cf.* Schmetzer, 1983a). The chemical data of the present sample with

1.88% FeO and 0.15% Cr_2O_3 support this interpretation. In summary, the colour of the zinc-bearing taaffeite with extraordinarily high refractive indices is intermediate between the normal bluish-violet coloration due to iron and the red coloration due to chromium and vanadium. The chemical formula of the zincian taaffeite is given as

$$Be(Mg_{2.51}Zn_{0.33}Fe_{0.15}Mn_{0.01})(Al_{7.99}Cr_{0.01})O_{16}$$

or idealized as

$$Be(Mg, Zn, Fe)_3Al_8O_{16} \text{ with } Mg>Zn, Fe.$$

In addition to zinc-bearing spinel, gahnospinel, which has been known for a long time from Sri Lanka (Anderson *et al.*, 1937), zinc-containing taaffeite from Sri Lanka is a second oxide mineral with an isomorphic replacement of magnesium and zinc. In both minerals, zincian spinel and zincian taaffeite, the investigation of the refractive indices will strongly indicate a distinct zinc content in any unknown not yet analysed sample. A complete solid solution between common spinel and gahnite, $MgAl_2O_4$ and $ZnAl_2O_4$, is known to exist in nature. The zincian analogue of taaffeite with the idealized formula $BeZn_3Al_8O_{16}$, however, has not yet been found.

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SOMETHING STRANGE

By R. KEITH MITCHELL, F.G.A.

I have illustrated in Figure 1 one of the most puzzling 'gem' items I have ever found. It is a composite flat plaque-like arrangement, 23 × 19mm, of concretions, most of which resemble halved pearls which have been cemented in place with their sawn side uppermost.

I say 'resemble half pearls' advisedly, for they are brownish in colour and are pearl-like only in their structure of concentric layers around a variety of nuclei. The six larger 'pearls' differ slightly in appearance and in four of them an opaque white layer is seen just below the last 'skin' or layer. The nuclei also differ and in two instances appear to be glassy—possible sand grains. All nuclei are large by comparison with those expected in normal pearls. The six large sections fluoresce white under long ultraviolet wavelengths (365 nm) but their centres are inert.

FIG. 1

In addition there are twelve smaller 'half-pearls', more baroque in shape than the large ones and with even more pronounced nuclei. These are quite brown in colour and do not

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fluoresce. One appears to have formed around a fragment of malachite. The green stone in the centre of the plaque is definitely malachite and there are twelve other mineral fragments embedded in the brown mastic used to hold them all to the base. The latter seems to be a black ceramic of some kind, since there is none of the reaction to acid one would get from black marble used, for instance, in Florentine mosaics. Some of the mineral fragments resemble banded marble and do fluoresce rather faintly. The mastic, which looks resinous and is badly cracked, fluoresces a fairly strong orange brown. The 'pearls' and marble all effervesce with acid but four half circles of brown material do not, and are probably chalcedony of some kind.

It has not been possible to identify the concentric concretions. Short of breaking the thing to examine the uncut surfaces one cannot really determine whether they are indeed unusual pearls or whether they are calculi of mammalian origin. Gall-stones have been suggested, for these form in a similar way and have a pearl-like structure. They could even be sections cut from tubular accretions such as stalagmites, but I am inclined to doubt this. The presence of fairly obviously granular centres argues against it, as does the finely grained concentric layering.

It does seem probable that the larger fluorescing sections are of different nature or origin from that of the smaller non-fluorescing ones.

There seems to be little doubt that the plaque was assembled deliberately to exhibit the marked concentric layering of its components. When new it was probably polished, but wear and age have removed the gloss from all but the harder parts, such as the enigmatical white layer in four of the larger sections, and the 'sand' grain nuclei.

For me this thing is unique. Has any reader seen anything like it? Can anyone throw light upon the 'pearls' that were used and the reason for showing them the wrong way up? The world of the surgical student is prone to a strange sense of humour and I feel that this could be in some way connected with that profession.

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A LOW-COST SPECTROSCOPE UNIT HAVING ADDITIONAL GEMMOLOGICAL APPLICATIONS

By JAMES B. NELSON, Ph.D., F.G.S., F.Inst.P., F.G.A.

McCrone Research Associates Ltd, 2 McCrone Mews, Belsize Lane, London, NW3 5BG.

INTRODUCTION

The spectroscope is being increasingly used as a trustworthy diagnostic aid in the characterization of both coloured gemstones and diamonds.

It would appear, however, that students and beginners often encounter difficulties in the effective use of the instrument. The most commonly-voiced complaint is that the instructor could see the spectrum of a given stone quite clearly, but that the student could not. There would probably be no such problem if all students had as much observing time as they wished using one of the many costlier spectroscope-stoneholder-illuminator table units.

The hand-held spectroscopes of both prism and diffraction types are now decreasing in price, so that more students, graduates and jewellers are able and willing to purchase them. However, it is found that the inexpensive penlights often used to 'drive' them are less than satisfactory. They do not provide enough good white light for more than a few minutes observation time. The light rapidly becomes yellower and more feeble. Whilst it requires no manipulative skill to direct the light on to the stone, some dexterity is needed to adjust the spectroscope so as to obtain a satisfyingly uniform spectrum from the light rays which leave the stone. Even when this is accomplished, there is no convenient way to stabilize the image so that other persons are able to inspect the identical spectrum.

This paper describes a spectroscope unit which overcomes these objections. At the same time, with the help of ancillary items, it provides a tool for other kinds of gemmological investigations.

DESCRIPTION OF THE BASIC UNIT

Construction.

The positions of the various components of the basic unit are shown in *Figure 1.* A photograph of the basic unit and some of the optional components is shown in *Figure 2.* The unit consists of a

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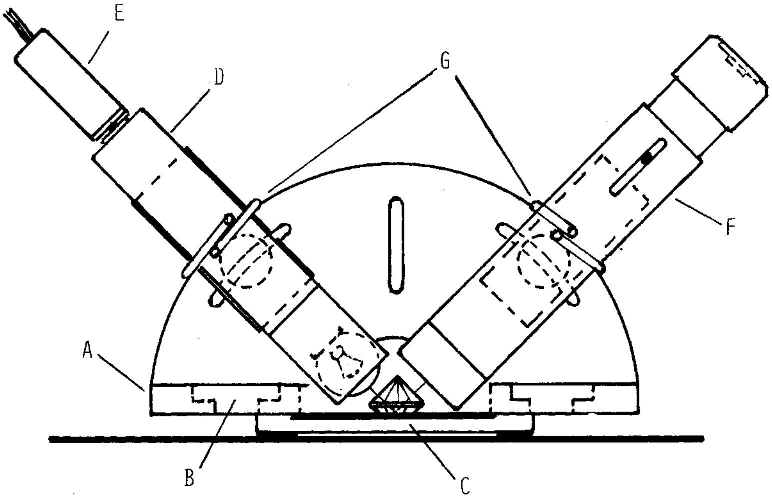

FIG. 1. Sketch of the spectroscope unit.
A. Base. B. Recessed hole for pinhole disc.
C. Gemstone rest: black velvet topside, mirror underside.
D. Barrel light source. E. Jackplug.
F. Fixed slit prism spectroscope.
G. Vee-blocks with wire clamps.

rectangular black Perspex base with a large circular hole at its centre, on either side of which is a smaller hole. A clear Perspex semicircular plate is fixed vertically on this base. Three slots in this plate serve to clamp adjustable vee-blocks, any of which can hold a light source or a spectroscope.

The light-source body is a cylindrical barrel made of a tough black plastic. It has a shielded lamp bulb at one end and an electrical jack-plug socket connexion at the other. It can be firmly held on its vee-block by a finger-release clamp. In this way, the barrel can be rotated on its own axis or slid along the vee-block to suit the lighting conditions required. A thumb-screw in the vee-block allows the barrel to be positioned and tightly clamped on to the vertical plate.

The final component of the basic unit is a glass mirror. The reverse side of the mirror is covered with black velvet, and it is this upon which rests the table facet of the stone under examination.

Lamps and Power Sources.

Two types of lamp are available. Both have identical miniature Edison-screw bases. One is a round, clear bulb, with a straight-coiled filament lamp, rated at 5.5 volts and 1.65 watts. The other is of the kind used in penlights. It has a tiny condenser lens moulded on the bulb. This gives it a more directed ('collimated') light beam than the first. It has a rating of 2.2 volts and 0.55 watts. Whilst this has a much smaller light energy output than the first lamp, its smaller filament and collimated beam yields a greater light flux at the spectroscope eyepiece.

Both lamps are powered by a 240 volt mains isolating transformer, whose body plugs directly into the standard British 13 ampere mains socket. Through a switch in its base, it delivers three separate voltages.

With the 5.5 volts rated lamp, these settings deliver operating voltages of 2.74, 3.86 and 4.96, yielding operating wattages of 0.54, 0.92 and 1.35 respectively. The lowest voltage setting is used for the 2.2 volt rated lamp, giving an operating voltage of 2.35 and 0.62 watts. This shows it to be over-run by about 13%. Whilst this reduces the rated operating life of some 50 hours, this lamp (and the

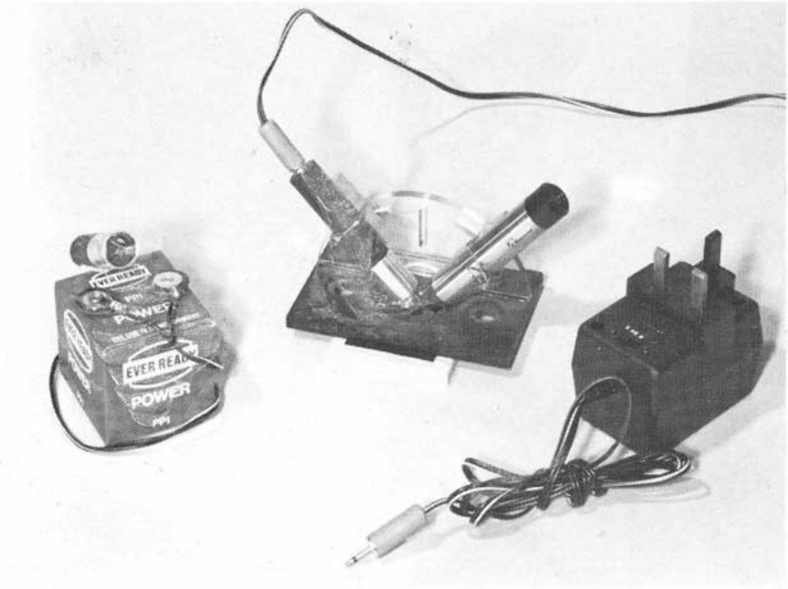

FIG. 2. Photograph of the spectroscope unit.
Centre: Basic unit with fixed slit prism spectroscope.
Right: Mains transformer power supply.
Left: Battery power supply. A slit attachment to the barrel light source which may be used with 'visual optics' is shown resting on top of the battery.

5.5 volt rated one) is quite inexpensive and easy to replace. The resulting greater light flux and the higher ratio of UV light to red light are compensating advantages.

With regard to its possible use in educational institutions, a vital feature of this light source is its complete electrical safety. No direct mains voltage can be reached by the operator's fingers. As it is an isolating transformer, mains voltage cannot be accidently transferred to the flex jack-plug.

The unit may occasionally be needed to examine rough and cut stones before purchase in remote places, where suitable mains supplies are not available. Recourse may then be made to either a mounted penlight for very short periods of observation, or to a large capacity 6-volt dry battery for extended periods. Provision has therefore been made to substitute a standard penlight on the same vee-block as that normally holding the barrel light-source. When the 6-volt battery pack is required, a second shorter flex is available. This has a jack-plug for the barrel light source at one end and a pair of connector clips for the battery pack at the other.

Spectroscopes.

Five types of inexpensive direct-vision spectroscopes may be used. Not unexpectedly, these have different features and, in particular, different diameters. For the basic unit, they are individually fitted with clamping vee-blocks to make them optically co-axial and also co-axial with those of the barrel light source and penlight. Again, like the light sources, the clamps can be released so that their tube axes can be rotated on their vee-blocks or slid along them, as needed.

Two of the spectroscopes are of the diffraction-grating type, and three are of the prism type. The first is an OPL instrument having a fixed, deep-set, but unprotected slit of 37 micrometres width and a focus fixed for normal vision. The second is an Ealing-Beck instrument having a dustproof, glass-protected, fixed slit, also of 37 micrometres width, but with an eyepiece draw-tube giving an adjustable focus.

The third spectroscope is a McCrone compound-Amici prism type having a luminosity at least equal to that of the OPL instrument. It has a glass-protected, fixed slit of 17 micrometres width and a variable focus drawtube. The resolution is high; the sodium doublet can just be discerned. With the two diffraction-type instruments it is not possible to separate the doublet in the blue region of the ruby spectrum; this can be done comfortably with the prism instrument. This makes it possible to distinguish between a ruby which has been cut with its crystallographic axis parallel to the table and one which has its axis oriented perpendicularly to the table. With the first situation, the 476.5 nm line is the stronger; with the latter, the 475.0 nm line is the stronger.

It could be argued that, with a low-wattage light source, there is a greater need to use a spectroscope having a variable width slit. Experience with the unit using such an instrument generally shows this not to be so. However, if such a facility is needed for some special purpose, such as that described later, a fourth spectroscope (McCrone) is available. Its variable slit is glass-protected and, apart from its greater barrel diameter requiring a different clamping vee-block, its other characteristics are identical to the fixed-slit instrument.

A clamping vee-block is also available as a holder for the well-known Rayner multislit prism spectroscope.

Among the general population, large variations are to be found in the actual focal distances associated with the most comfortable naked-eye viewing. Many of these differences in human vision arise from ageing processes in the crystalline lens of the eye. Apart from this, on using, say, a prism spectroscope, with the ruby doublet at 694.2/692.8 in sharp focus, the ruby doublet at 476.5/475.0 will be seen, but not resolved. For this and other reasons, a focusing eyepiece is one feature of a spectroscope which should be regarded as an important one.

When weak or even medium-strength absorption lines are known to be present in certain spectral regions of the gemstone under examination, the observer is often unable to see them. The reason for this is commonly a failure to obtain the maximum line resolution of the instrument in the desired region. Under these circumstances the three spectral emission lines at 436, 546 and the 577/579 nm doublet seen in any ceiling fluorescent lighting tube are helpful in checking that the slit width, line focus and filter-eliminated 'veiling' or glare have been correctly chosen. The absence of a well-placed emission line in the red end can be overcome by focusing on the group of strong red lines in the neon spectrum. This spectrum is conveniently provided by the small on/off pilot lamps found on many instrument power supplies. Probably the best checking source of all is the spectrum given by the new Philips

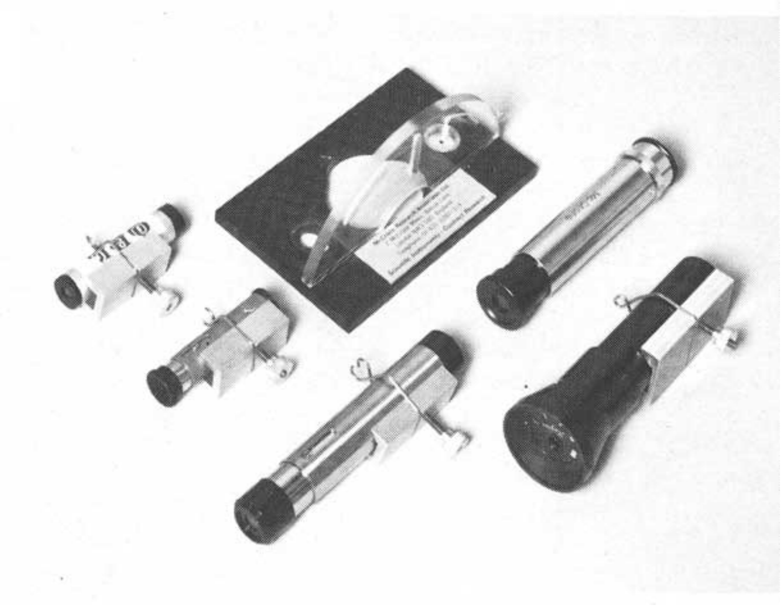

FIG. 3. Photograph of the basic stand with clamp-mounted spectroscopes.

SL*25 fluorescent bulb, intended as a replacement for the ordinary domestic 100 watt tungsten light bulb. Its spectrum shows an abundance of sharp lines from red to violet.

The choice of either a diffraction-type or a prism-type instrument lies with personal preference based on experience with both types. However, it has become the author's invariable practice with an unknown stone to use first the fixed-slit, focusing eyepiece diffraction instrument, followed by the fixed-slit, focusing eyepiece prism instrument. The switching of the vee-block-mounted, prealigned instruments takes little time. Details missed by one are often picked up by the other.

Figure 3 shows the basic stand to which can be attached any of the above-mentioned five spectroscopes, From left to right they are:

1. OPL diffraction; fixed slit, fixed eyepiece.
2. Ealing-Beck diffraction; fixed slit, focusing eyepiece.
3. McCrone prism; fixed slit, focusing eyepiece.
4. McCrone prism; continuously variable slit, focusing eyepiece.
5. Rayner prism; six different-width fixed slits, focusing eyepiece.

THE PRINCIPAL REASONS FOR THE NEW UNIT

A commonly held view is that lamps of a power of 150 watts or greater are needed to obtain acceptable spectra. This view was perhaps nourished by the recommendations of B. W. Anderson, who favoured the use of a suitably-housed 240 volt, 500 watt projection lamp.(1) The light from this is conducted to the gemstone by means of a 600 ml spherical, flat-bottomed flask filled with water. This effectively removes all the accompanying heat (infrared) energy and condenses the visible light energy. Alternatively, the flask is filled with a saturated solution of copper sulphate. This also removes the heat, but provides as well a condensed, band-free light source with a much enhanced proportion of violet to red light. This is especially useful in penetrating the 'blue gloom' region, and in eliminating the purple veiling which often obscures the violet region in the spectra of red-to-orange transmitting stones.

This view has been reinforced by the commercial availability of many new 'cold-light' fibre-optics light sources. These are sold as free-standing units or are built into table spectroscopes. Their design and construction are by no means simple and this is reflected in their high cost. The filament of a low-voltage, quartz-halogen lamp of 150 to 250 watts is placed at one focus of an ellipsoidal mirror. The polished entrance face of a shielded glass fibre light guide receives the light energy at the other focus. A toughened glass heat filter is interposed between the two foci. The heat filter only partially absorbs the very large amount of heat energy generated. The heat re-radiated by the filter itself, together with the heat emitted by the rest of the unit, is largely removed by a convector air fan. However, unlike the 500-watt/water-flask arrangement, a considerable amount of heat energy remains and can still reach the gemstone. This has been reported to have caused damage to some heat-sensitive stones, causing minute discontinuities to develop into visible cracks.

Another feature of 'cold-light' sources is one which does not seem to be generally known. An examination of the graph relating percentage transmission to wavelength of a 600 mm length of the standard glass-fibre light-guide cable reveals a fact not unimportant to gemmologists. The graph is shown in *Figure 4.* It can be seen from this that there is an appreciable drop in the light transmitted as it approaches the blue, violet and particularly ultraviolet regions. This yellowing of the white light as it passes through the cable can, of course, be corrected by the careful choice of a blue glass filter. However, this light-balancing expedient cannot restore the loss of the gemmologically informative ultraviolet components.

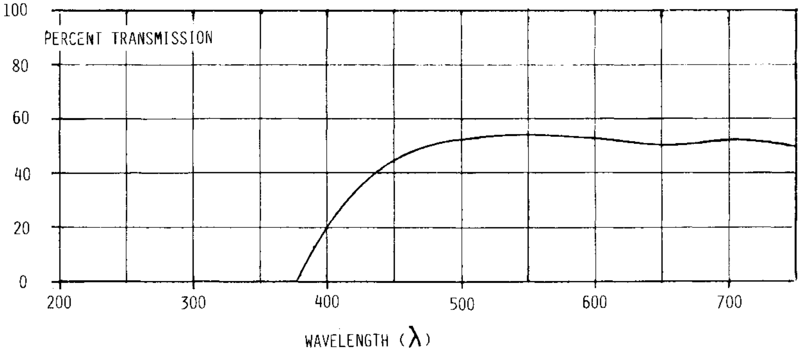

FIG. 4. Spectral transmission curve of a 600 mm long glass-fibre-bundle light guide cable. Percentage transmission versus wavelength (nm).

The results with the spectroscope unit described here have shown that such high wattage sources are not really mandatory. Thus one reason for the new unit is to provide an adequate and cool light flux at low cost. Another is to enable a desired spectrum, once obtained, to be easily recoverable, and, equally important, to be visually stable for inspection by others, again at low cost.

Whilst of lesser importance, the light source with its 5.5 volt rated lamp serves as a mechanically-adjustable illuminant for the critical-angle refractometer* and for the 10× hand loupe. It is particularly convenient when using the technique with faceted stones recommended by Gübelin(2) for distinguishing natural and naturally-coloured sapphires from synthetic and from artificially-coloured sapphires. This present variant consists of placing the stone in a circular glass dish with a flat bottom† and covering it with colourless methylene iodide.‡ The dish is held over or on the vertically-aligned barrel light source, which is fitted with a white

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* A refractometer eyepiece filter is available for this; it is fitted with a special 'monochromatic sodium' gelatine filter.

† The glass immersion cell of Gemmological Instruments Ltd (Catalogue No. 1223) is ideal for this purpose.

‡ The free iodine in deeply-coloured methylene iodide can be removed with a piece of clean copper. A few hours' contact will render the liquid almost colourless; after decolorization the copper should be removed.

diffuser cap, and the stone viewed with a 10× hand loupe. Gübelin states: ". . . In the case of a naturally-coloured sapphire, all the facet edges, including the girdle, disappear, and only a blurred blue shimmer remains. Diffusion-coloured sapphires, on the other hand, display a patchy coloration, and all the facet edges, including the girdle, appear sharply defined, just as if the sapphire had been drawn with a blue pen on the bottom of the glass dish . . .".

Compared with viewing the stones directly in air, this immersion technique has proved to be much more informative when viewing inclusions in all transparent coloured stones. It is particularly useful with rough stones and results in a simplification of the usual procedure. Here, a rough stone need not possess a polished flat "window", as is the case for critical examinations in air. Of course, the appropriate RI-matching liquid must be used. In the author's experience, three liquids, glycerine (1.47), benzyl benzoate (1.57) and methylene iodide (1.74) meet the need for low, medium and high RI stones respectively.

There is a further useful feature of the barrel light source. It entails removing the lamp shield and substituting the tiny condenser-lens lamp (rated voltage of 2.2) for that normally used (rated voltage of 5.5). With its more directed (collimated) beam, this hand-held or base-held source can more easily probe into awkward crevices when dealing with large pieces of jewellery having stones in closed- or open-backed settings. Whilst a penlight can do this task just as well, the prolonged viewing times usually needed for spectroscopy make its use impracticable.

The physics of light propagation state that the light intensity varies in inverse proportion to the square of the distance from the source, i.e., it falls off very rapidly with distance. It follows that, if possible, the lamp lens should be brought into near contact with the gemstone surface. The spectroscope slit should also be placed as near to the gemstone as possible. When this is done, it is surprising to see how much cool white light flux is available for visual or spectroscopic examination from a lamp of so small a wattage (0.6 watts).

OTHER USES OF AN EXTENDED UNIT

Apart from the above-mentioned applications, the unit can be adapted for other types of gemstone examination with the aid of various accessories.

Polariscope and Conoscope.

An accessory has been designed for converting the basic unit into a polariscope and a conoscope. The polariscope consists of a barrel light source attachment bearing the necessary diffusing and polarizing filters in pre-aligned positions. The transparent gemstone is placed on the glass-protected polarizing filter. As with conventional polariscopes, the stone is rotated and viewed through the crossed analysing filter situated above it (see *Figure 5*).

More often than not, faceted glass gemstone simulants produce effects under crossed polars which indicate that they are doubly-refracting and therefore not glass. With a little experience these distinctive images can be recognized as characteristic of 'frozen-in' internal elastic stresses. It was felt that it would be instructive to include as a polariscope accessory a clear, colourless, rectangular, notched bar of a synthetic resin which possesses a particularly high sensitivity to stress birefringence (piezobirefringence). When the bar ends are held between the fingers and thumbs to produce a bending force, polarizing colours appear. Depending on the degree of pressure applied, the colours vary from grey to purple and first appear at the notch. Releasing the pressure causes the stresses and therefore the colours, to vanish. Within gemstone pastes, the internal stresses are generated during the rapid cooling stage, and at room temperature the elastic stresses are 'frozen-in'. Unlike the carefully 'annealed-out' stresses of optical glass, gemstone pastes are not considered valuable enough to warrant the additional annealing treatment.

Four accessories are needed to convert the polariscope into a conoscope. The first is a small, removable, iris diaphragm cell which is used to support the faceted stone or the windowed 'rough'. The table of the gemstone or flat of the 'rough' is arranged so as to be uppermost. A careful setting of the iris diaphragm allows this to be done so that the specimen does not drop out during any subsequent manipulation. The iris diaphragm cell bearing its stone is then placed on the polariscope table.

The second accessory is a small, well-annealed, polished glass sphere, about 4 mm in diameter. It is attached by epoxy cement to one end of a thin, horizontal metal rod, which in turn is bolted to a small rectangular block. The block, with its supported glass sphere, is able to rotate and to move up and down freely on the vertical rod which connects the analysing filter to the polarizing filter table beneath. With this rod to simplify handling, the sphere is placed in

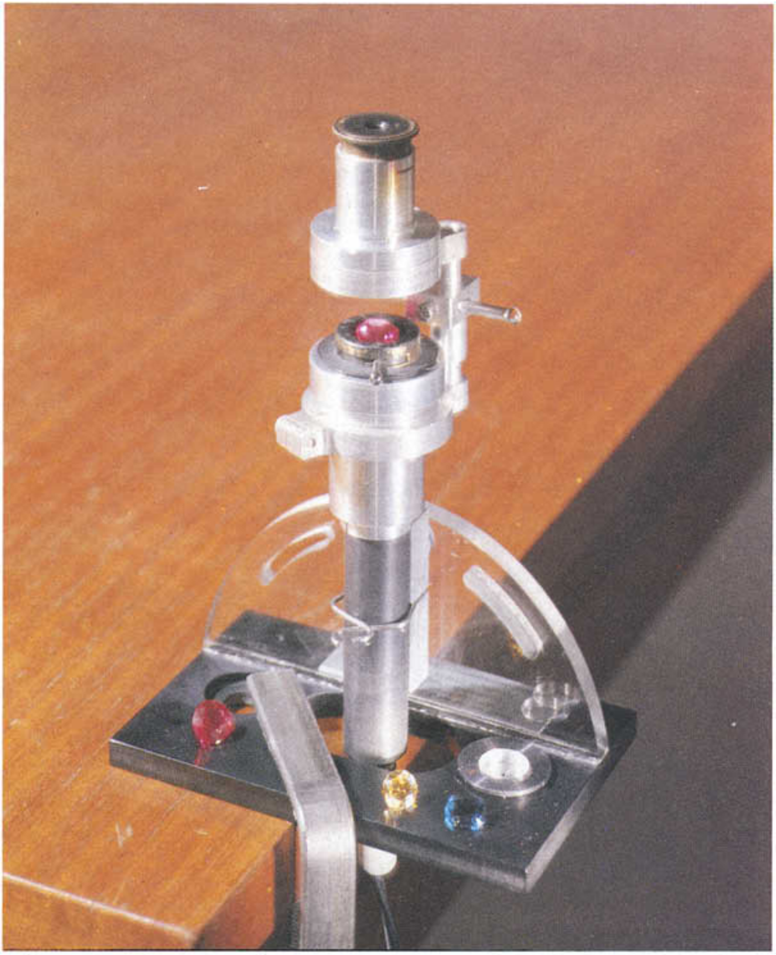


FIG. 5. Photograph of the polariscope-conoscope accessory.
This is shown attached to the barrel light source, which is vertically mounted on the basic stand. To accommodate the projecting jackplug, the whole unit is G-clamped to the edge of a desk or bench. For polariscope (orthoscopic) viewing, the gemstone is placed either directly on the polarizing filter table or supported as shown on the iris diaphragm cell for ease of rotation and tilting. The removable focusing magnifier is used for both orthoscopic and conoscopic viewing.

FIG. 6. Enlarged view of the conoscope condenser arm.
The glass sphere condenser is shown resting directly on the table surface of the gemstone. It can be swung in and out of the polariscope's axis as required (see Figure 5). The aperture lever of the iris diaphragm cell also serves to rotate the gemstone on this axis. This rotation is a vital process in following the behaviour of non-centred conoscopic images.

direct contact with the flat surface of the stone (see *Figure 6*). It is then sometimes possible to see at once the image of an optical interference figure lying within the sphere, provided that the stone is of a uniaxial or biaxial character. Unstressed isometric stones or pastes will not, of course, exhibit optical interference figures.

More often than not, no figure appears. However, tilting the stone in the cell about its geometrical axis, with the sphere still in contact, will sometimes coax into view the whole or part of a figure. The presence of a figure gives indisputable evidence that an optical axis of the gemstone mineral coincides with, or is very close to, the vertical geometrical axis of the gemstone.

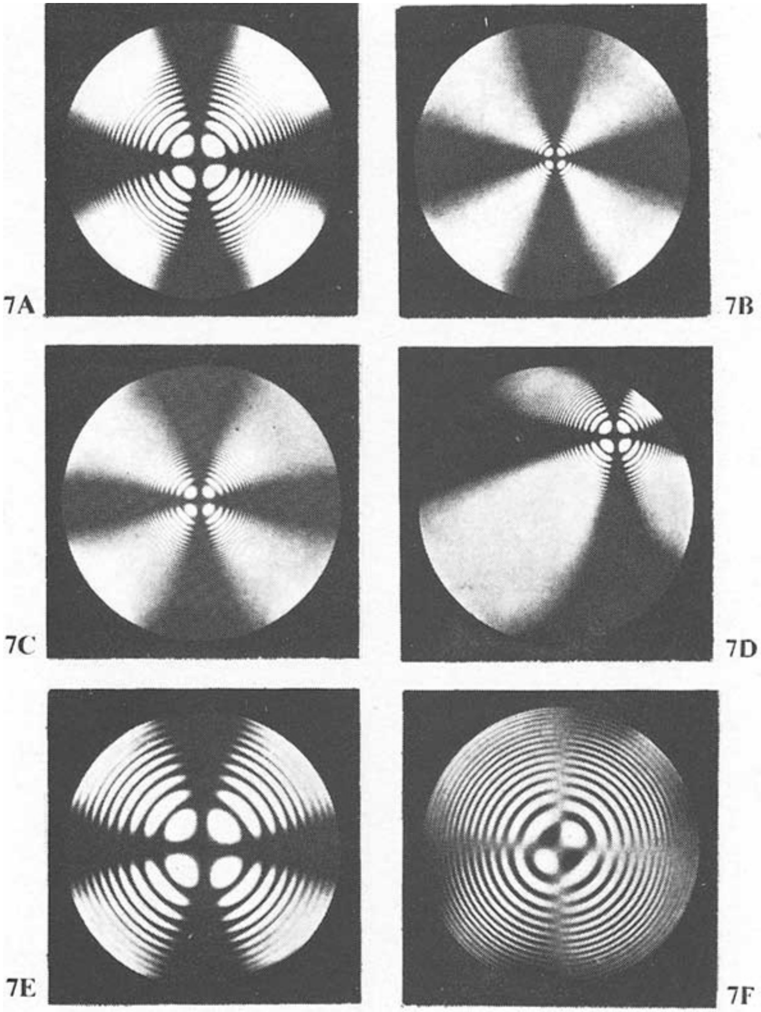
For example, it is almost certain that a high quality ruby will display a well-centred uniaxial figure. This is because such a ruby will have been cut so that viewing it directly through the table will exhibit the best possible colour for that stone. This viewing direction is that where only the more reddish omega (ordinary) ray of the ruby will be seen.

The two optic axes of biaxial stones will seldom be seen in the same interference image. Possibly one or other of a single melatope (as the image pattern at the point of emergence of an optic axis is called) will be visible. More probably, the off-centred trace of a melatope will be glimpsed. This will be the case where particular care has been taken by the cutter to present the optimum colour of the stone. Usually, however, no interference figure will be discernible through the table facet. This fact is often related to the practice adopted by native cutters. Their first concern, understandably, is to obtain the maximum weight and clarity from a piece of 'rough', and less to extracting its best colour.

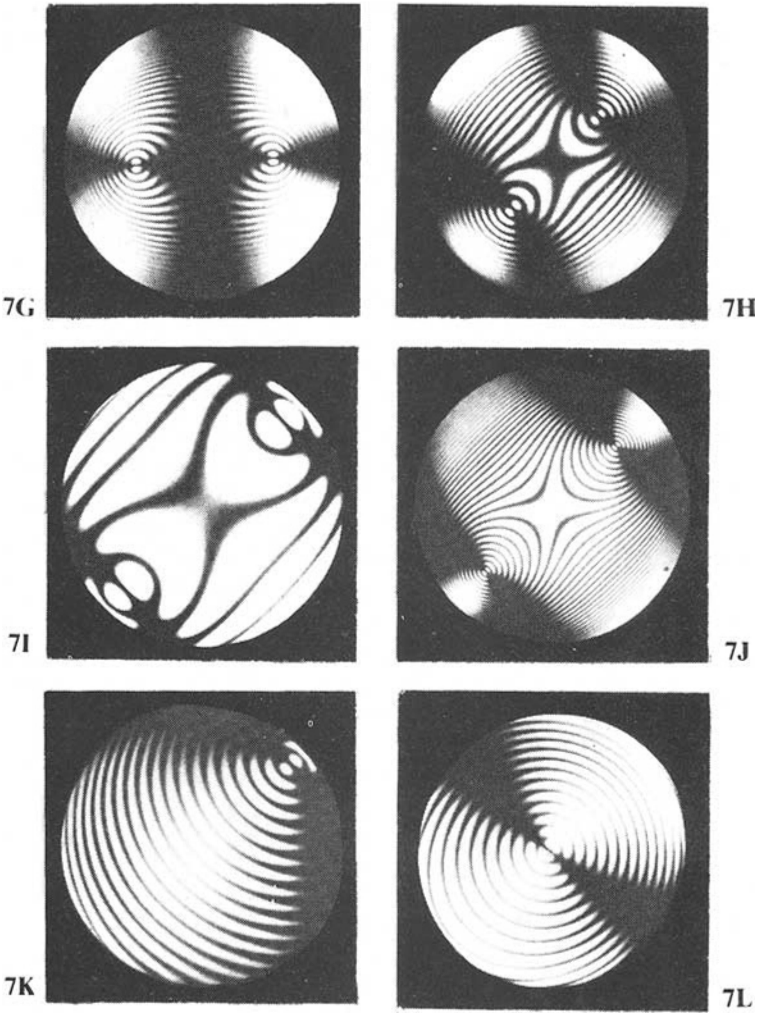
If the gemmologist is sufficiently determined, a recognizable uniaxial or biaxial figure can usually be found. Should the stone possess other largish facets, the search will not be so prolonged. One useful trick discovered by the author is to moisten the glass sphere with the merest touch of any immersion oil. This direct optical coupling between sphere and stone usually helps to intensify and sharpen an otherwise indistinct interference figure. *Figure 7* illustrates the appearances of centred and off-centred uniaxial and biaxial figures.

FIGS 7A to 7L. Uniaxial (7A to 7F) and biaxial (7G to 7L) interference figures ('conoscopic images'). All are of plane-parallel polished sections of single crystals photographed in highly convergent sodium light (wavelength = 589nm) under crossed polars.

FIG. 7A. *Calcite*. Section thickness 0.5 mm; cut at 90° to the optic axis.
FIG. 7B. *Calcite*. Section thickness 3.0 mm; cut at 90° to the optic axis.
FIG. 7C. *Calcite*, Section thickness 1.0 mm; cut at 90° to the optic axis.
FIG. 7D. *Calcite*. Section thickness 0.9 mm; cut at 80° to the optic axis.
FIG. 7E. *Zircon*. Section cut at 90° to the optic axis.
FIG. 7F. *Zircon*. Same section as 7E, but with a superimposed quarter-wave retardation plate having its 'slow' direction oriented north-east to south-west. The image seen is that characteristic of a uniaxial positive crystal.



FIGS. 7A to 7F. Uniaxial interference figures ('conoscopic images'). See p. 512 opposite. (For biaxial interference figures see p. 514).



FIGS. 7G to 7L. Biaxial interference figures ('conoscopic images'). See p. 515 opposite. (For uniaxial interference figures see p. 513).

The third conoscope component is a positive eyepiece lens combination mounted in a focusing cell. Its purpose is to magnify the small image seen within the glass sphere. This is needed in order to discern greater detail in the figure. It is perched in a recess on the analysing filter table of the polariscope. Because the height of the glass sphere will vary with the thickness of the gemstone in its cell, provision has been made for focusing the lens.

The final conoscope accessory is a set of three cells similar in dimensions to the iris diaphragm cell. They are intended as aids to the recognition of the image patterns of the optical interference figures. One cell contains a mineral section showing a uniaxial figure. Another is a cleavage slip of muscovite mica, showing both melatopes of a biaxial figure. By both rotating and tilting these cells on the polarizing filter table, one is able to become familiar with the general behaviour of these images. The biaxial figure changes with rotation and orientation in a much more complicated way than the uniaxial one. Without simple standard specimens such as these, the process of recognition of off-centred figures from actual faceted stones would take very much longer.

The last of the three cells contains a quarter-wave plate. This is a device which can be used in conjunction with the conoscope to indicate whether the optical sign of the gemstone (uniaxial or biaxial) is positive or negative. However, the explanation of its use is far from simple. For this reason, the treatment of the subject will be deferred until a later time. Should one wish for a fuller account of conoscopic figures a good introduction is given in the textbook by Gay,(3) or in an excellent article by Robinson.(4)

FIGS 7A to 7L. Uniaxial (7A to 7F) and biaxial (7G to 7L) interference figures ('conoscopic images'). All are of plane-parallel polished sections of single crystals photographed in highly convergent sodium light (wavelength = 589nm) under crossed polars.

FIG. 7G. *Aragonite.* Section thickness 0.5 mm; cut at 90° to the acute bisectrix. Parallel (extinction) position.

FIG. 7H. *Aragonite.* Section as above, but rotated 45° to the 'diagonal position'. Showing 'eyes' (melatopes) and 'brushes' (isogyres). Optic axial angle (2V) = 18°.

FIG. 7I. *Muscovite mica.* Section at 90° to the acute bisectrix (cleavage plate). Diagonal position, showing 'eyes' and 'brushes'. 2V = 39°.

FIG. 7J. *Sphene.* Section cut at 90° to the acute bisectrix. Diagonal position, showing 'eyes' and 'brushes'. 2V = 24°.

FIG. 7K. *Diopside.* Section cut parallel to the 100 plane. Diagonal position, showing a single off-centred 'eye' and 'brushes'. 2V = 58°.

FIG. 7L. *Topaz.* Section cut at 90° to an optic axis. Diagonal position, showing a single centred 'eye' and 'brushes'. The concentric circles are termed 'isochromatic lines'. 2V = 62°.

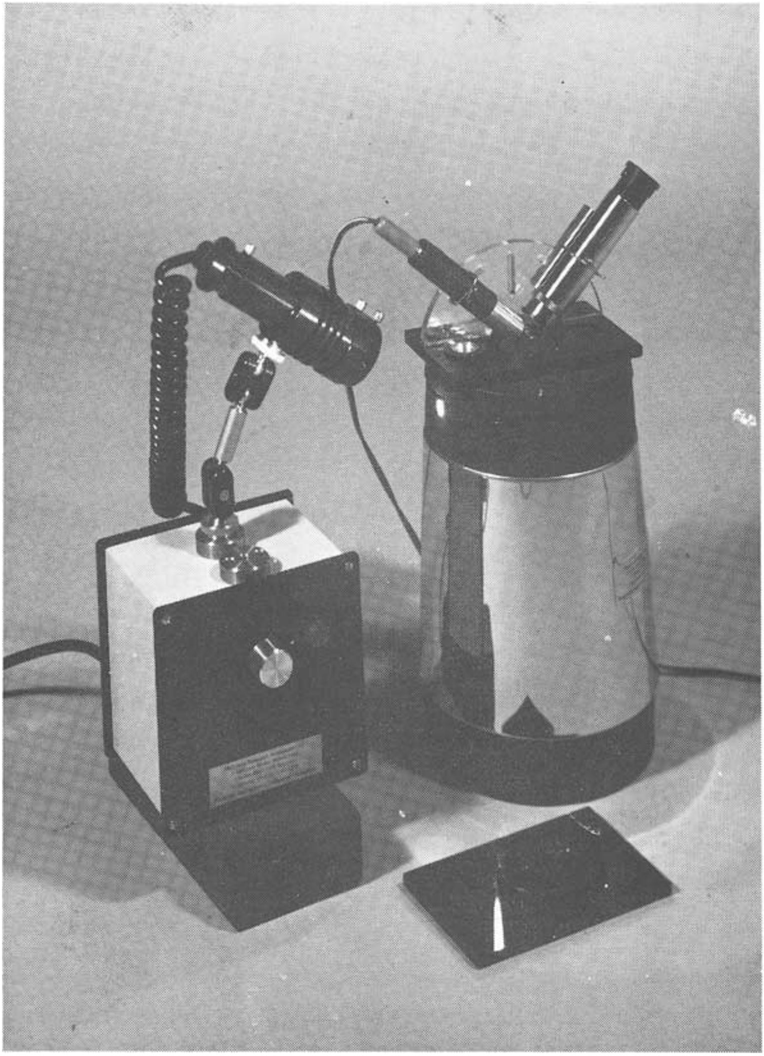


FIG. 8. Photograph of the gemstone cooling unit.
The spectroscope unit is shown in position on top of the vacuum-flask cooling unit. The alternative free-standing light source is shown on the left. A stone alignment jig is shown at the bottom.

Gemstone Cooling Unit

In recent years the hand spectroscope has been found to be an indispensable tool for the characterization of diamonds, whether uncoloured, coloured or artificially coloured. The absorption lines in the visible region are generally narrow and faint. However, by viewing the stone at a sufficiently low temperature, they usually become much enhanced in intensity and sharpness. Additionally, lines which cannot be seen at room temperature often become prominently visible when cooled.

In well-funded gemmological laboratories, low temperature instrumentation has been developed to exploit the effect. Studies utilising this highly complex equipment have elicited many new facts about the properties and histories of faceted diamonds.(5,6,7,8,9,10) These facts now promise to be of routine diagnostic value to the less well-endowed gemmologist, provided low-cost, easy-to-use apparatus is available.

A simple stone cooling device for this purpose has now been developed. It is basically a 'cold-finger' type and can be seen on the right in the photograph of *Figure 8*. The spectroscope unit is shown in position on top of the vacuum-flask cooling unit.

A 13 mm diameter copper heat-conduction rod is fixed centrally in the screw-on insulating lid and reaches almost to the inside bottom of the flask. The upper end of the rod is machined flat and projects slightly above the top of the lid. The gemstone is placed table facet down and centrally on the exposed flat copper surface. No thermal coupling liquid is needed to assist the conduction of heat from the gemstone to the cooled rod.

The top surface of the lid serves as a convenient platform upon which to support the spectroscope unit. The unit is prevented from accidentally sliding off sideways by the presence of a flat metal ring. This ring is attached to the platform so that it lies coaxially with the copper rod. In turn, the ring fits loosely into the large circular hole in the base of the spectroscope stand.

In this way, the gemstone rests directly on its copper rod perch in the normal viewing mode. The gemstone-aligned spectroscope unit can now be placed on the platform or removed from it, without disturbing the gemstone.

Table I shows the temperatures reached by various cooling mixtures, the best of course being liquid nitrogen. Nitrogen gas boils off at −196°C and this becomes the equilibrium temperature

TABLE I. Temperatures of some freezing mixtures

	Temperature	
Equilibrium mixture	°C	K*
Room temperature	22	295
Crushed ice plus water	0	273
Crushed ice plus sodium chloride crystals (NaCl)	−21	252
Crushed ice plus crushed anhydrous calcium chloride ($CaCl_2$)	−55	218
Crushed ice plus potassium hydroxide pellets (KOH)	−65	208
Crushed carbon dioxide pellets plus methylated spirits†	−78	195
Collins-Scarratt liquid nitrogen evaporator apparatus(5)	−153	120
Boiling point of liquid nitrogen. Collins apparatus(6)	−196	77
Hofer-Manson cryogenic compressor cooling system(7)	−218	55
Absolute zero	−273	0

* K = °C + 273.18

† There are liquids which are as satisfactory, but less inflammable than methylated spirits. They are:

Isopropyl alcohol	Cat. No. 59310
"Dowanol 33-B" (1-Methoxy-2-propanol)	Cat. No. 65280

Obtainable from:

Fluochem Ltd, Peakdale Road,
Glossop, Derbyshire, SK13 9XE, U.K.

Also obtainable from the above suppliers:

Calcium chloride anhydrous lumps	Cat. No. 21080
Potassium hydroxide pellets	Cat. No. 60375

Solid carbon dioxide ice ('Cardice') pellets are obtainable from:

The Distillers Company (Carbon Dioxide) Limited,
Cedar House, 39 London Road,
Reigate, Surrey, RH2 9QE, U.K.

of the copper rod. The body temperature of the gemstone will not be exactly at this point; thermocouple measurements show this to be about 5 to 10°C above it.

A full 25-litre Dewar flask of liquid nitrogen is fairly cheap and can be delivered when requested at one's door. It will take about two months to boil away completely. Admittedly, liquid nitrogen supplies can be a problem for the gemmologist who requires only an occasional examination. However, most gemmologists know a friend in some scientific or medical institution who has ready access to constant liquid nitrogen supplies.

The frosting-over of the gemstone surface becomes a nuisance when the humidity is high. There comes a point when the spectrum becomes less visible. Then the spectroscope unit and the stone are removed, the stone and its perch are rubbed free of the rime, and the stone and unit restored. The alignment is unchanged and the stone's temperature reaches that of the perch in about 15 seconds.

For prolonged frost-free examination, recourse may be made to a separate device. A gentle stream of moisture-free nitrogen is obtained by evaporation from a separate Dewar flask containing liquid nitrogen. The stream is conducted on to the stone by means of a tube, whose holder is bolted on to an existing screw-tapped hole in the base of the spectroscope unit.

With certain diamonds, it can transpire that the blue-violet region requires greater light intensity than the tiny condenser-lens lamp can deliver. This can be supplied by a separate free-standing light source equipped with a heat-absorbing filter. It is shown on the left of *Figure 8*. The condensed spot of cool light can be seen focused on the upper side of the stone cooler unit.

If the use of liquid nitrogen is not feasible, Cardice pellets or even the water/chemical mixtures are still quite effective in sharpening and enhancing the absorption lines.

Here, instead of using a stream of cold, gaseous nitrogen for producing a moisture-free micro-climate for the stone, a slow stream of dried air at room temperature can be used to prevent the formation of rime. All that is required is a small rubber diaphragm pump and a long, wide, glass cylinder with rubber stoppers and glass tubes at both ends. The cylinder is filled with a suitable desiccant, like blue-dyed silica gel. Although the air stream is at room temperature, the temperature of the stone scarcely rises.

With liquid nitrogen cooling, the 415.5 and 478 nm lines of the

Cape series diamonds (Type 1a) and the 497 and 504 bands of the green-fluorescing Brown series become highly visible, as does the 595 band of some treated stones. When the 'Red' colour filter is placed over the eyepiece of the prism spectroscope, even the elusive GR1 line at 741 nm can be discerned in some irradiated stones. This same filter is also helpful in detecting the presence of the radiation-related 637 line in yellow Type 1b stones.

Little work has yet been carried out on the effect of the cooling device on stones other than diamond. A 0.79 carat, colourless zircon showed only a very faint line at 653.5 nm at room temperature. With liquid nitrogen, this line was greatly enhanced and sharp lines were revealed at 589.5, 537.5 and a faint one at 562.5 nm. A puzzling doublet at about 515 nm also appeared.

Observation of the ruby red doublet proved to be instructive. At room temperature, even with some care, the fixed-slit prism spectroscope could not resolve the doublet. With liquid nitrogen, the narrowing and strengthening of the lines made the separation just visible.

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THE RAYNER DIAMONDSCAN— A TEST REPORT

By PETER READ, C.Eng., F.G.A.

When the reflectivity meter was first introduced in the mid-1970s(1,2,3,4), one of the drawbacks in its design was the inability of the instrument to test stones below about 0.15 ct in size. This was due to the need for the main facet of the stone to cover completely the test aperture, whose diameter in some early models was as large as 1.5 mm and is seldom much smaller than 1 mm in more recent models.

Another problem was the difficulty in testing stones which were recessed in their mount. Attempts to overcome this difficulty were made by providing an annular recess to take the stone's setting claws, by forming the test platform into a flat-topped cone or by mounting the infrared light-emitting diode and associated photo-detector in a probe housing. Because of the dimensions of the photo elements, and the need for them to be angled for precise reflection alignment to the surface of the test stone, even the two latter modifications only allowed for the testing of stones of 0.5 ct and upwards.

Although the majority of reflectivity meters are battery-operated and are therefore portable, they do need to be placed on a flat surface for ease of operation, and this is not always possible when making tests away from the workbench (e.g. when checking stones at an auction).

In 1984, following extensive testing of ten prototype units by the jewellery trade, the Rayner Optical Company introduced their DiamondScan model (Figure 1). This version of the reflectivity meter is designed to overcome some of the drawbacks of the more conventional models, and, as its name implies, is specifically developed for identifying diamond and its simulants.

The Rayner DiamondScan is a self-contained battery-operated reflectivity probe, and because of its optical design it is capable of testing stones down to 0.05 ct in size, even if these are recessed in their mount. This has been made possible by coupling the infrared light-emitting diode and its photo-detector via a bifurcated glass-fibre light guide to a stainless steel test tip having an internal diameter of 0.75 mm.

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FIG. 1. View of the Rayner DiamondScan showing (centre, right to left) its bar-graph type indicator, stainless steel test tip, removable test platform and dust cap.

The infrared rays from the diode are effectively collimated by both the fibre optics and the stainless steel test tip. With the stone correctly aligned, the infrared rays impinge on its surface at right-angles (thus satisfying one of the requirements of the Fresnel equation linking reflectivity with refractive index) and are reflected back to the photo-detector.

To reduce the instrument to pocket-size proportions, the output from its photo-detector amplifier is coupled to a bar-graph type display unit rather than a meter. The first segment of this display is labelled 'B', and in the absence of any reflected rays this segment lights to indicate that the battery voltage is adequate for use (if the light extinguishes, the battery needs replacing). The remaining segments are labelled 1 to 9, and the instrument is calibrated (as indicated in Table 1) so that these coincide with the reflectivity of diamond (represented by a diamond symbol against segment 8) and its simulants. A user calibration preset control is accessible through a hole in the side of the unit's case.

TABLE 1

Bar-graph Reading	Diamond	Identification	
		Simulant	Description
B			Battery condition check
1		X	Glass
2		X	Quartz (colourless Beryl, Topaz)
3		X	Corundum, Spinel
4		X	Zircon, YAG
5		X	GGG
6		X	Cubic Zirconia
7		X	Strontium Titanate
◆	X		Diamond (Calibration point)
9		X	Rutile (metals)

The DiamondScan is powered by either a small 7-volt mercury battery or by a 6-volt lithium battery (the latter being available from camera shops and having a shelf life of ten years). With either battery the operating voltage of the unit's printed circuit board is stabilized at 3.4 volts. To further ensure maximum battery life, the unit is only energized when the pocket clip is pressed against the instrument's body (the clip acts as the on/off switch). Because of the sensitivity of the electronic circuits, a thermal stabilizer has been incorporated to maintain the instrument's calibration over a temperature range of 15 to 25°C.

For operating convenience, a black plastic test platform is provided, and this can be fitted over the probe's test tip to give a reference surface when checking non-recessed stones of 0.25 ct and upwards (Figure 2). When not in use, the probe tip is protected from dust by the test platform and a dust cap. Inadvertent operation of the unit is prevented by inserting it into a carrying sleeve which insulates the pocket clip from the body of the probe.

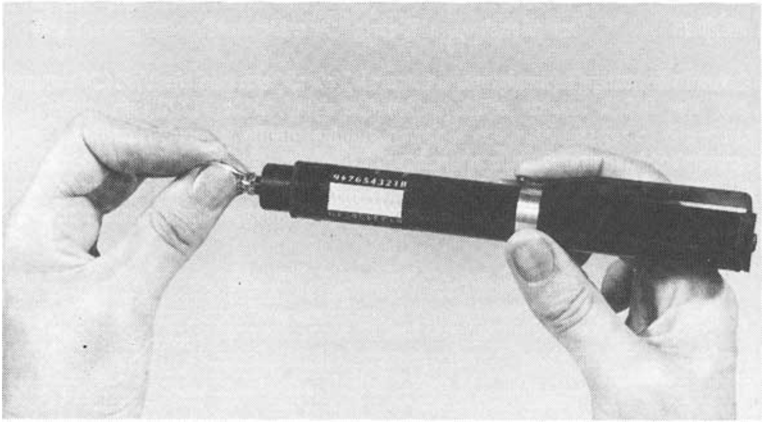

FIG. 2 Using the DiamondScan with the test platform in position.

Besides replacing the battery, the only maintenance required is to keep the test tip and the end of the light guide free from dirt. This is effected by removing the probe tip nozzle and gently dusting the exposed end of the light guide. Any dust particles can then be blown out of the probe tip tube. To maintain calibration, the probe tip nozzle is replaced with its white alignment dot opposite a similar dot on the side of the instrument's case.

During tests made with the DiamondScan using diamonds, diamond simulants and coloured stones, it was clear that some skill was necessary in aligning the probe's test tip squarely (i.e. at right-angles) to the surface of the gem in order to achieve the highest correct reading on the bar-graph indicator. The need for practice in the use of the instrument is emphasized in the operating leaflet, where it is recommended that those users not familar with probe-type reflectivity testers should first attempt to obtain correct readings with a relatively large stone (0.5 ct and upwards) using the black plastic test platform.

Apart from the fact that the DiamondScan is held in one hand, and the stone under test in the other, the use of the test platform makes operation of the instrument similar to that of the conventional desk-type reflectivity meter. The surface of the gem can be easily referenced in the correct orientation against the surface of the test platform, and providing the test aperture in the probe tip is completely covered by the area of the gem's facet, the appropriate maximum reading is obtained without further adjustments.

With much smaller stones (down to 0.05 ct), and with any stone whose mount protrudes beyond the surface of the table facet, it is necessary to use the DiamondScan with the test platform removed. Here, particularly with small stones, care must be taken to ensure that the test tip remains in the centre of the table facet while orientating the stone first in one plane (e.g., horizontally) and then at right-angles to this (e.g., vertically) to obtain the maximum reading.

With unmounted stones, this task is made simpler by first securing the stone in prong tweezers or in a stone display holder. Although it may negate one of the instrument's flexibility features, users have found it easier, at least initially, to sit down and steady both elbows on a horizontal surface when using the DiamondScan, particularly when testing several stones in succession as with an eternity ring. The method of holding the ring or stone against the probe tip (as described in the operating leaflet) using the index finger to steady the hand against the side of the instrument (see Figure 3) certainly makes the testing of stones of any size much easier.

Although the illustrations in Figures 2 and 3 show a right-handed user, left-handed operation simply involves rotating the

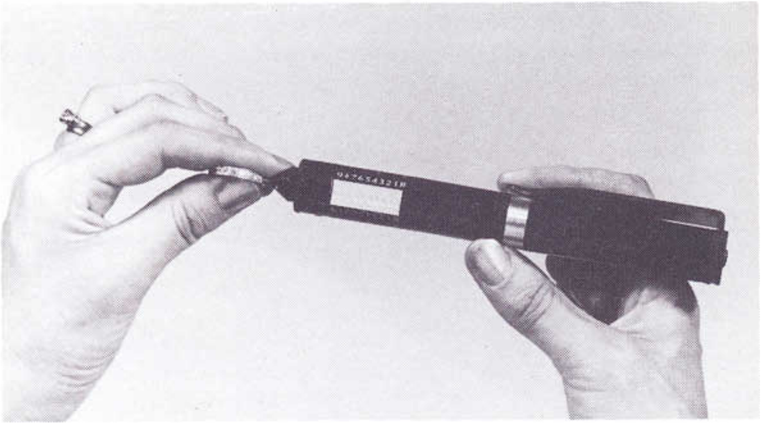

FIG.3 Method of testing small stones with the test platform removed.

pocket clip through 180 degrees (without unscrewing the battery holder) and reading the bar-graph against the alternative scale provided.

As can be seen on the scale of a standard reflectivity meter, the reflectivity values for diamond and the principal diamond simulants (e.g., glass, quartz, corundum, YAG, GGG, CZ, strontium titanate, diamond, rutile) are evenly separated. This fact enables the DiamondScan to be calibrated so that these stones fall into the nine segments of the bar-graph display. Although the instrument has been designed to test for diamond and its simulants, it is also possible, with care, to test for the coloured varieties of some gem materials. This is not recommended, however, because of the possibility of ambiguity caused by the response range of each segment.

As with any reflectivity instrument, one of the most important requirements when testing stones on the DiamondScan is that the surface of the gem is free from dust, grease and scratches. Because it is difficult with this instrument to shield the rear of the stone from ambient light, it is also important that tests are not carried out under high-level lighting. Correct operating procedure is summarized by the following instructions which are printed on the body of the instrument:

'Use in subdued light'

'Clean test surface'

'Adjust angle for maximum reading'

Dimensions of the DiamondScan are 170 mm long by 18 mm diameter. The batteries used are Duracell TR-175 (7-volt) or Duracell PX28L (6-volt).

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GEMMOLOGICAL ABSTRACTS

Balfour (I). *Famous diamonds of the world, I – XII,* Indiaqua, 20–31, 1979–1982. (Series continuing – parts XIII (Indiaqua 32, (1982/4)) onwards are separately abstracted.)

The series deals in turn with a celebrated diamond, giving the history and details of the stone where known. Stones discussed in parts I to XII are the Niarchos diamond, the Brunswick blue, the Woyie River diamond, the President Vargas, the Shah diamond, the Jonker, the Dresden Green, the Amsterdam diamond, the Florentine diamond whose whereabouts is at present unknown, the Lesotho brown diamond, the Regent diamond, and the Colenso diamond (stolen from the British Museum (Natural History) in 1965 and never recovered). M.O'D.

Balfour (I.). *Famous diamonds of the world, XV. The 'Hastings' diamond.* Indiaqua, 34 (1983/1), 129–33, illus., 1983.

This 101 ct rough diamond was presented as a gift in 1786 by the Indian prince Nizam Ali Cawn to King George III. Because of the involvement of Warren Hastings, the first Governor General of India, in its presentation, a rumour started that the diamond constituted a personal bribe by Hastings to the King, and the resulting scandal caused the stone to be known as the 'Hastings' diamond. Warren Hastings was formally impeached, but was cleared on all counts in April 1795. Although nothing since appears to have been heard of the diamond, the author suggests that the missing stone was part of the Crown Jewels and was mounted in the coronation crown of George IV. He further suggests that subsequently the stone became the principal 32.2 ct diamond in the Westminster Tiara which was made in 1837 for the Marquis of Westminster. In 1959, the tiara was purchased by Harry Winston Inc., and the diamonds sold privately to an undisclosed collector. P.G.R.

Balfour (I.). *Famous diamonds of the world, XVI. The 'Excelsior' diamond.* Indiaqua, 35 (1983/2), 131-4, illus., 1983.

The 995.2 metric carat 'Excelsior' diamond, which rates as the second largest rough diamond ever found, was discovered at the open-cast site of the Jagersfontein mine in South Africa's Orange Free State in 1893. The discovery was made by an African boy who was shovelling gravel into a truck (his reward was £500 and a horse with saddle and bridle). The rough stone was of top colour, but contained numerous internal black spots, both features characteristic of Jagersfontein diamonds. The stone was shipped to the London offices of Messrs Wernher, Beit & Co., the largest of the ten firms that comprised the London syndicate, and was eventually dispatched to Messrs Asscher of Amsterdam for cutting. Possibly because of the numerous inclusions, the 'Excelsior' was cut into twenty-one relatively small stones, the largest being of pear shape and weighing 69.68 metric carats. No single large stone therefore was produced from the rough, a fact which caused some people to believe that the higher commercial rewards associated with a greater number of more saleable small diamonds had outweighed any thought of producing a large stone of historic importance. The author suggests that one of the larger stones cut from the 'Excelsior', a 46.50 ct pear-shaped diamond, was the principal stone in a pendant auctioned at the Park-Bernet Galleries, New York, in 1957. P.G.R.

BALFOUR (I.). *Famous diamonds of the world, XIX. The 'Hope' diamond.* Indiaqua, 38 (1948/2), 127–38, illus., 1984.

The 'Hope' diamond is well known for both its rare colour, a sapphire-like dark blue, and for its reputation as a bringer of misfortune to many of its previous owners. However, as Ian Balfour points out, this gem has not always been unlucky for its owners, nor has it caused their early demise. The Kollur mine, in the vicinity of Golconda, India, is said to have been the source of the stone. What is known is that after Tavernier returned from his final voyage to the Orient he sold a dark blue diamond to Louis XIV of France (the 'Sun King') in 1669. Tavernier himself was certainly not affected by any 'curse' associated with the stone and died of old age in Russia at 84. The 'Tavernier Blue', as the stone became known, was recut in 1673 to a heart-shape which weighed 69.03 metric carats (the original weight being around 110.5 metric carats). In its new form, the diamond was called the 'Blue Diamond of the Crown' and was worn in various ways. Louis XV who succeeded the 'Sun King', had the stone mounted in the decoration of the Golden Fleece insignia, and this was passed to the next King of France, Louis XVI. Although Marie Antoinette (Louis XVI's wife) was said to be 'cursed' by ownership of the blue diamond, there is no record of her ever having worn it.

During the revolution in France, the blue diamond was sent for safe keeping with other Crown Jewels to the Garde Meuble, which was part museum and part furniture store. On 16th September, 1792, the Garde Meuble was broken into and the blue diamond and other gems were stolen. Early in the nineteenth century a dark blue diamond weighing around 44 ct mysteriously made its appearance in London. In 1830, this blue diamond was sold to Henry Philip Hope and acquired the name of the 'Hope' diamond. After the owner died, the stone was inherited by his eldest son, who died at the comparatively early age of 54. The son's wife retained the diamond and in 1887 bequeathed it to her younger grandson with the proviso that he adopt the name of Hope. The grandson, Lord Francis Hope, subsequently attempted to sell the stone to solve his financial difficulties. Francis Hope's eldest sister took legal action to prevent the sale, but in 1901 Hope succeeded in securing permission to dispose of the diamond, which was sold to Adolf Weil of Hatton Garden, London. From 1909 onwards, the diamond passed through many ownerships, some of which were associated with both lurid and bizarre happenings, which added to the legend of the diamond's 'curse'. Finally, in 1949, it was purchased together with other jewellery by the late Harry Winston, who, in 1958 presented the 'Hope' diamond to the Smithsonian Institution in Washington, D.C. P.G.R.

Balfour (I.). *Famous diamonds of the World, XX. The 'Cullinan' diamond.* Indiaqua, 39, (1984/3), 123-32, 10 figs, 1984.

A very full account of the finding of the World's largest known diamond, its presentation to King Edward VII, subsequent cutting and eventual incorporation in the British Crown Jewels. R.K.M.

Bank (H.). *Aus der Untersuchungspraxis.* (Notes from the Laboratory.) Z.Dt.Gemmol.Ges., **33**, 1/2, 79–83, 1 photomicrograph in colour, bibl., 1984.

Dark brown chrysoberyl from Sri Lanka was found to show extremely high RI, n_x 1.760, n_y 1.762 and n_z 1.770, while colourless enstatite from Sri Lanka had very low RIs, n_x 1.650, n_y 1.653 and n_z 1.659. Rough 'emerald pieces' were offered on the market, but found to be green dyed quartz. The correct designation of synthetic Knischka rubies as an overgrowth on a seed of Verneuil ruby is discussed. E.S.

Bastos (F.M.). *Irradiated topaz and radioactivity.* Gems Gemmol., **XX**, 3, 179–80, 1984.

Writer explains method of nuclear treatment to make topaz blue and says that residual radioactivity fades very rapidly. R.K.M.

Beattie (R.), Brown (G.). *Facetable prehnite.* Aust. Gemmol., **15**, 8, 258–9, 3 figs. 1984.

Facet grade material found at Wave Hill, Northern Territory, and cut by R. Beattie. SG 2.92, RI 1.613–1.640, DR 0.027, H 6½. Translucent to transparent. R.K.M.

Bosch-Figueroa (J.M.), Fuente-Cullell (C. de la). *El color de las gemas.* (The colour of gems.) Gemologia, **20**, 61–2, 18–31, 4 figs, 1984.

The cause of colour in gemstones is explained. M.O.D.

Brown (G.). *The Snow gemmological spectroscope.* Aust. Gemmol., **15**, 8, 259–62, 2 figs, 1984.

A new spectroscope assembly employing the normal prism instrument but with addition of fibre optic light source for mounted rings. Favourable report. R.K.M.

Brown (G.). *Topaz.* Wahroongai News, **18**, 10, 27–31, 1984.

An account of this species apparently culled principally from mineralogies and heavily over-weight on atomic structure and crystallography. R.K.M.

Brown (G.), Bracewell (H.). *Harts Range sunstone.* Aust. Gemmol., **15**, 8, 263–74, 26 figs (24 in colour), 1 map, 1984.

Exhaustive account of this feldspar and of the Harts Range mine in Northern Territory. SG 2.57, RI 1.520–1.527. Some identified as aventurine-microcline, others as untwinned microcline-microperthite and one illustration as aventurine-orthoclase, which seems a little unusual. R.K.M.

Brown (G.). Kelly (S. M. B.). *Alexandrite-chrysoberyl from Zimbabwe.* Aust. Gemmol., **15**, 8, 275–8, 6 figs (1 in colour), map, 1984.

Examination of crystal and poor quality faceted alexandrites from Fort Victoria, Zimbabwe. SG 3.8, RI 1.749–1.758, DR 0.009. Typical chromium absorption, many inclusions. R.K.M.

Brown (G.), Snow (J.). *Two new thermal testers.* Aust. Gemmol., **15**, 8, 281–5, 7 figs, 1984.

Instrument evaluation of Eickhorst Thermolyzer and Diamontron testers. Committee recommends either instrument for thermal testing of diamond if instructions are followed with care. R.K.M.

Bursil (L. A.). *Small and extended defect structures in gem-quality Type I diamonds.* Endeavour, **7**, 2, 70–7, 4 figs, 1983.

Gem quality diamonds may have up to one atom of carbon per 1000 replaced by nitrogen. The structures formed by the nitrogen in various states of aggregation range from a few atomic diameters up to platelet shapes several microns in size. The understanding of such defect structures may be related to studies of the geological origin and evolution of various diamond species. The ability to control the defect structures may have important practical applications. R.A.H.

Cassedanne (J.). *Le chrysobéryl au Brésil.* (Chrysoberyl in Brazil.) Revue de Gemmologie, 80, 7–13, 11 figs (4 in colour), 1984.

Details of 23 occurrences of chrysoberyl in Brazil are given and constants of the stones listed. Some information on mining is also provided. M.O'D.

Campbell (I. C. C.). *The Independent Coloured Stone Laboratory(I.C.S.L.).* South African Gemmologist, **1**, 1, [7–9]*, 1984.

I.C.S.L. is thought to be the only laboratory in S. Africa accredited under the auspices of the Accredited Gemologists Association (U.S.A.). Some stones tested recently include (1) a suspect ruby (slightly over 1 ct) with a triangular inclusion (identity unknown, but looking like some platinum inclusions in some synthetics) not yet definitely identified as natural or synthetic, (2) a heat-treated Verneuil synthetic ruby with a small 'fingerprint' inclusion (curved striae, not visible under 60× magnification, were just seen with immersion in methylene iodide and high intensity lighting reflected and transmitted through an iris diaphragm closed to the size of the stone), (3) another natural-looking Verneuil synthetic ruby with induced fractures (curved striae visible only when immersed), (4) two large apparent aquamarines, which were in fact crown glass coloured by an element other than cobalt, (5) a 3 ct bluish-green stone purchased as tsavorite [*sic*], which was tourmaline coloured mainly by vanadium, (6) a small golden-yellow natural sapphire which faded in direct sunlight, and (7) a round emerald-green doublet from Zimbabwe showing normal Sandawana-type RI on the table and tremolite inclusions, but pavilion was clean glass of surprisingly good colour, and the join (coinciding with the girdle) was free of trapped air. J.R.H.C.

Caveney (R. J.). *De Beers Diamond Research Laboratory Report No. 13, Advances in diamond's 'Exotic' applications.* Indiaqua, 35 (1983/2), 125-7, illus., 1983.

Although non-abrasive applications for industrial diamond are small in total economic value when compared with their more common abrasive uses (e.g. in

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* Page 7 is not numbered and pages 8 and 9 are numbered 2 and 3. – Ed.

drilling, sawing, grinding, lapping and polishing), there is however a range of more exotic applications where the unique properties of diamond make it the preferred, if not the only, choice of material.

These non-abrasive applications include the diamond window used to protect the spectral analysis equipment in the Pioneer space probe to Venus, the precision diamond knife used in eye surgery and microsurgery, and the diamond high-pressure cells used in the preparation of solid crystalline hydrogen for rocket fuel or as a source of hydrogen for fusion. P.G.R.

CAVENEY (R. J.). *De Beers Diamond Research Laboratory Report No. 17: The origin of diamonds.* Indiaqua, 39 (1984/3), 115–19, 2 figs, 1984.

The growth of diamonds in the depths of the earth and their subsequent emplacement in kimberlite pipes have been the subject of debate for many years. At first it was thought diamond crystallization was associated temporally and spatially with the genesis of kimberlite. More recently, following the laboratory growth of diamond at low pressures and temperatures (known as metastable diamond growth), it has been proposed that diamonds crystallized from kimberlite magma at shallow depths during or after emplacement (known as the 'shallow-earth theory'). However, the study of mineral inclusions in diamond (chromite, olivine, garnet and clinopyroxene) and their phase equilibria has provided clues to both the chemistry of diamond genesis and the conditions under which diamond grew. These studies, and the great difference found in the ages of these inclusions and that of kimberlite (which is comparatively young), confirm that diamond grew under diamond-stable conditions at depths in excess of 150km below the earth's surface. P.G.R.

CHADWICK (J. R.). *Big stones offset low grade at Lesotho's diamond mine.* Indiaqua, 29, 27–33, 17 figs (13 in colour), 1981.

The mine at Letseng-la-Terai in Lesotho lies at 10 500 feet above sea level. At the time of writing 7.6% of the production was larger than 14.7 ct. M.O'D.

COZAR (J.S.). *Contribución al conocimiento de la naturaleza, génesis e identificatión de las inclusions presentes en los rubies sintéticos de fusión Verneuil y de melt-fluxion Chatham y Kashan.* (Contribution to knowledge of the nature, genesis and identification of the inclusions present in Verneuil fusion and Chatham and Kashan flux-melt synthetic rubies.) Bol. Soc. Españ. de Mineralogia, **7**, 31–6, 11 figs, 1983.

Fluid and crystalline inclusions in synthetic rubies are described and illustrated. The rubies grown by the Chatham process frequently contain tabular crystals of platinum. R.A.H.

DABEK (Y.). *L'opale d'Australie.* (Australian opal.) Monde et Minéraux, 65, 32–6, 9 figs (6 in colour), 1985.

Attractively-illustrated general piece on opal from Australia. M.O'D.

DAHANAYAKE (K.). *Modes of occurrence and provenance of gemstones of Sri Lanka.* Mineralium Deposita, 15, 81–6, 2 figs, 1980.

Most of Sri Lanka iiis underlain by Precambrian metamorphic rocks from the amphibole, cordierite and pyroxene facies. Gem minerals are found mostly in the cordierite and pyroxene facies in the South-western and Highland groups of rocks. Sources of gem minerals are garnetiferous gneisses, cordierite gneisses, marbles and pegmatites. M.O'D.

DANILO DO RIO (S.). *Double production d'émeraudes pour la mine de Sta-Thérèse de Goias (Brésil).* (Emerald production from the mine at Sta Thérèsa in the state of Goias, Brazil, is doubled.) Revue de Gemmologie, 81, 21, 2 figs, 1984.

Production at the mine is increasing and yield is expected to double. The mining area is divided into five zones, Trecho Velho, Trecho Nove, Cata ze Maria, Invasion, Mine des Barbus. Up to 5000 miners are employed. M.O'D.

DESHPANDE (M. L.). *Diamond search in India.* Indiaqua, 26, 27–35, 36 figs (33 in colour), 1980.

The use of Landsat imaging as a technique for identifying potential diamond deposits is suggested, with notes on the history of diamond mining in India. M.O'D.

DORLING (M.), ZUSSMAN (J.). *An investigation of nephrite jade by electron microscopy.* Mineralog. Mag., **49**, 1, 31–6, 8 figs, 1985.

Two specimens of tremolite from Wyoming, and also a richterite from California, all with jade texture, have been examined by TEM using ion-thinning for specimen preparation. The specimens contain clusters of very small lath-like crystallites with their *c* axes approximately parallel but in a range of azimuthal orientations. It is suggested that these clusters, which are themselves in various orientations, are the result of post-tectonic recrystallization of strained amphibole crystals, the new crystals inheriting the *c*-axis orientations of the old. The extreme toughness of nephrite jade is attributed to a number of sub-microscopic features observed, including the sizes, habits and orientations of the crystallites and the nature of the grain boundaries. R.A.H.

EDRISINGHE (B.). *XIX International Gemmological Conference, 1983.* J. Gemmologists Association of Sri Lanka, 1, 41–9, 1984.

An account of the 1983 International Gemmological Conference,* which was hosted by the Gemmologists Association of Sri Lanka, with particular emphasis on the organizational preliminaries and the social side. J.R.H.C.

FAZLI (M. S. M.). *International Coloured Gemstone Association.* J. Gemmologists Association of Sri Lanka, 1, 31–2, 1984.

Records the foundation of I.C.G.A. at a Preliminary Meeting at Acapulco in January-February 1984† and its objects. The next meeting will be at Idar-Oberstein in May 1985. J.R.H.C.

FRYER (C. W.), ed., CROWNINGSHIELD (R.), HURWIT (K. N.), KANE (R. E.). *Gem Trade Lab Notes,* Gems Gemol., **XX**, 3, 167–73, 18 figs in colour, 1984.

A 'phantom' growth plane in diamond; swirled graining in a cubic zirconia and snow-like white (ZrO_2) powder-filled negative inclusions in another are described and illustrated. Green-dyed beryl; a Lechleitner coated 'emerald' with unpolished

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* See *J. Gemm.*, 1984, XIX(1), 92–4. – Ed.

† See *J. Gemm.*, 1984, XIX(3), 288. –Ed.

facets and a near colourless enstatite crystal offered as ekanite are also nicely depicted.

Pearls. An abalone pearl of exceptional size (78 x 46 x 12mm) illustrated with its parent shell. Keshi ('accidental' fresh-water pearls) were found to be tissue-nucleated salt-water pearls and probably Australian. White cultured pearl necklace x-rayed showed opaque shadows at drill-holes, reminiscent of silver-stained black pearls. Imitation pearls in Biwa shapes were M.O.P. centred. Seed pearl rope proved to be glass centred imitation. Another seed pearl necklace had imitation pearls intermingled with natural pearls.

Turquoise backed with metal-loaded epoxy-resin matrix in a closed setting brings the comment that stones of this type in such settings should be assessed on a 'so far as mounting permits' basis. R.K.M.

Fryer (C. W.), ed., Crowningshield (R.), Hurwit (K.N.), Kane (R. E.). *Gem Trade Lab Notes.* Gems & Gemmology, **XX**, 4, 228–33, 18 figs (17 in colour), 1984.

A small faceted diamond with a *loose* diamond inclusion is illustrated. Indian carved 'emerald' and enamel necklace was found to be carved quartz with green backing. Oolitic opal is compared with sugar-treated opal. The first Tennessee cultured pearls are examined and discussed. Bluish-black cultured pearls proved to be stained with a web-like pattern of colour in some. 'Strawberry' quartz dark brown star owed its star to oriented crystals of goethite, not to reflection. Small corundum bead owed its colour to red substance in drill hole. A 20 ct faceted ruby proved to be a doublet with synthetic colourless spinel top and Verneuil ruby base; reason for such an artefact is obscure. Red-purple and a pinkish-orange sapphire proved by chalky fluorescence to short UV light to be heat-treated stones. Pinkish-purple natural spinel had colour shift to pink in incandescent light, long UV gave moderate chalky yellow-green fluorescence. A brownish-grey tourmaline cat's-eye had large hollow tubes partly filled by a plastic, leaving bubbles. R.K.M.

Garcia Gimenez (R.), Gil Sanchez (I.), Garcia Guinea (J.), Leguey Jumenez (S.). *Mineralogía de las maderas silicificades de Palmaces de Jadraque (Guadalajara).* (Mineralogy of the silicified wood of Palmaces de Jadraque, Guadalajara.) Bol. Soc. Españ. de Mineralogía, 7, 115–22, 1 map, 8 figs, 1983.

The mineralogy of agatized woods in volcaniclastic host rocks on the shore of the Palmaces de Jadraque reservoir, NE. of Madrid, has been studied. The cellular structures have been replaced by chalcedony and iron oxides; 20% of the cells have retained their nucleus, now composed of framboidal aggregates of pyrite cubes 1μm across. The pyrite develops inside the nucleus and the cells are filled with opal while the iron oxides line the cell walls. The colour changes depend on the intensity of this process. R.A.H.

Grigoriev (A. P.), Kovalsky (N. V.). *Working of diamond with metal.* Indiaqua, 39 (1984/3), 47-54, 13 figs (2 in colour), 1984.

The authors work at the Institute of Geology in the Yakutian Branch of the Siberian Department of the U.S.S.R. Academy of Sciences, and deal with the problems of natural diamond origin.

A striking phenomenon was observed by these researchers during an experiment on diamond crystallization carried out at atmospheric pressure. When a piece of metal foil was placed on a diamond and heated in a hydrogen atmosphere, the foil progressively sank into the body of the diamond to form a smooth-walled hole. The simplicity of producing various intricate hollows in diamond by use of the technique caused the researchers to explore its possible application to the working of diamond. The resulting project is now in its tenth year, and the method has been patented in several countries, including the U.K.

The mechanics of the technique are quite simple. A suitably shaped piece of iron or nickel foil is placed on the surface of the diamond, and this dissolves the diamond-carbon over the area of contact. The dissolved carbon diffuses through the foil, reacts with hydrogen at the foil's upper surface and is removed as methane. As a result of the dissolving of the diamond on the lower surface of the foil, and its conversion to gas on its upper surface, the foil sinks uniformly into the diamond. Several factors aid the process: diamond readily dissolves in certain metals just as if it were ordinary black carbon; because of carbon's small atom size, it diffuses fairly quickly in a metal; the carbon dissolved in a metal is chemically much more active than diamond and reacts readily with hydrogen.

The authors believe that the possibility of using this thermochemical process to etch an image on to the face of a diamond may bring engraved diamonds into fashion. Other uses for the technique include the improved sharpening of diamond knives used for eye surgery, cutting diamond gear wheels, wire sawing of diamond, the boring of square holes through diamond for wire-drawing applications, and the shaping of synthetic polycrystalline diamond. Rough diamond flats or cleavage fragments, which if it were not for the hardness of their crystal orientation would be an ideal shape for the Princess cut, can now be formed by thermochemical working.

P.G.R.

GÜBELIN (E.). *Opale aux Mexico.* (Opals from Mexico.) Lapis, **10**, 1, 23–30, 25 figs in colour, 1985.

The whole of the Mexican opal industry is reviewed with particular attention to the inclusions found in opal from Queretaro. Much of the included material is cristobalite or goethite. M.O'D.

GUNAWARDENE (M.). *Inclusions in taaffeites from Sri Lanka.* Gems Gemol., **XX**, 3, 159–63, 8 figs in colour, 1984.

46 taaffeites were obtained from nine different gem areas and examined for inclusions. Apatite, phlogopite, spinel, muscovite and negative crystal inclusions were identified. R.K.M.

GUNAWARDENE (M.). *A close examination of platinum inclusions in Chatham blue and orange sapphires.* J. Gemmologists Association of Sri Lanka, 1, 33–7, 6 figs (3 in colour), 1984.

Chatham flux-grown synthetic blue and orange sapphires contain platinum inclusions, which prove their synthetic nature. J.R.H.C.

GURNEY (J.). *Formation of the diamond.* Indiaqua, 23, 63–4, 2 figs in colour, 1979.

A short account of modern theories of diamond formation with reference to kimberlites and mineral inclusions. M.O'D.

GURNEY (J.). *The Monastery mine.* Indiaqua, 29, 21–4, 13 figs in colour, 1981.

The Monastery mine is in the eastern Orange Free State, South Africa. Production is high but the quality very variable. M.O'D.

GURNEY (J.). *What is kimberlite?* Indiaqua, 23, 57–9, 5 figs (3 in colour), 1979.

The composition of kimberlite and its discovery are discussed with reference to diamond mining. M.O'D.

HARDER (H.). *Zur Unterscheidung des Diamanten von Imitationen mit einfachen Mitteln.* (The investigation of imitation diamonds by simple methods.) Aufschluss, 35, 363–73, 2 figs, 1984.

Simple tests for the identification of diamond and its imitations are outlined. M.O'D.

HOFMANN (C.), HENN (U.). *Grüne Sphalerite aus Zaire.* (Green sphalerite from Zaire.) Z.Dt.Gemmol.Ges., **33**, 1/2, 72–4, 1 graph, bibl., 1984.

An English version of this article was published on pages 416–18 above. E.S.

HUGHES (R. W.). *Surface repaired rubies.* Aust. Gemmol., **15**, 8, 279–80, 4 figs in colour, 1984.

Another report on Thai rubies with glass-filled surface holes. R.K.M.

HURLBUT (C. S., Jr.), FRANCIS (C. A.). *An extraordinary calcite gemstone.* Gems & Gemmology, **XX**, 4, 222–5, 4 figs (2 in colour), 1984.

A 1156 carat faceted calcite exhibits multiple coloured images of the lower pavilion facets through the table due to the presence of a twin plane which passes diagonally between table and culet, doubling and quadrupling expected images. The apparent high degree of fire is due to the large size of the stone. R.K.M.

KANE (R. E.). *Natural rubies with glass-filled cavities.* Gems & Gemology, **XX**, 4, 187–99, 15 figs (14 in colour), 1984.

Investigates Thai rubies with large surface cavities in-filled with glass, probably at the same time as they were heated to improve colour. 'Glass-repaired' stones have been reported recently in Britain, United States and Thailand, where the faking probably originated. It enhances weight and appearance of the stone and is considered fraudulent unless openly declared whenever the stone is sold. Filled areas easily detected under magnification by difference in surface lustre when light is reflected from the polished surface. R.K.M.

KOIVULA (J. I.). *Inclusions in a better light.* Z.Dt.Gemmol.Ges., **33**, 1/2, 43–7, 6 figs in colour, bibl., 1984.

In gemmology the separating of natural gemstones from the synthetic counterparts is of utmost importance. The article stresses the tremendous role played by inclusions and the importance of the modern gemmological microscope. E.S.

KOIVULA (J. I.), ed., *Gem News.* Gems Gemol., **XX**, 3, 174–7, 2 figs in colour, 1984.

Diamonds: Indian cutters complain that Australian rough takes longer to facet. De Beers to start drilling for diamond near Kalgoorlie, W. Australia. 400,000 people now employed in diamond cutting in India, and 100,000 in cutting coloured stones. Aredor Diamond Mine, Guinea, will go into full production.

Coloured stones: A new corundum treatment. Asian Institute of Gemmological Sciences, Bangkok, has noticed rubies in which surface holes have been filled with fused glass to improve appearance and add to weight. RI of glassy in-fill is 1.52, often containing bubbles. Immersed in methylene iodide, filled holes stand out in high relief. [The British Gem Laboratory have also reported finding these – see pp. 293–7 above.]

GEMCP auction in Karachi held in May and emeralds and rubies from Pakistan and lapis lazuli and spinels smuggled from Afghanistan were offered. To decrease problems of illegal mining and smuggling in their own country joint ventures are offered to tribes in mining areas. [Double values with regard to smuggling?]

Zambia. Saudi Arabia emerald contract has not been honoured and is cancelled and a new one signed with a European and South American consortium.

Precious metals: brief reports from East Rand (platinum); Ghana; Japan; Knob Hill, Washington; Val d'Or, Quebec; Philippines and Zimbabwe (all on gold).

Simulated pearls offered in U.S. as 'premature cultured pearls' is unfair trading and rules have been changed to prevent it. Interesting glasses from Iimori Laboratory Ltd included 'maple stone', a dark green glass with leaf-like dendrites of devitrified synthetic cuprite. This is illustrated.

Smithsonian Institution displayed 'Dark Jubilee', Australian black opal of 318.44 ct, donated by Zale Corporation, and Star of Bombay sapphire bequeathed by actress Mary Pickford, for the Centennial of the National Gem Collection in April 1984.

R.K.M.

KOIVULA (J. I.), ed. *Gem News.* Gems & Gemology, **XX**, 4, 242-5, 3 figs in colour, 1984.

Diamonds. A 12 year loan of US$ 32 million to Northern Mining Corporation for Argyle, W. Australia development. 50 ct Golconda D diamond reappeared in Bombay and was bought by Graff Diamonds Ltd. John Sinkankas quotes 1975 report on diamonds in Thailand. At Cornell University a 4000°C laser at 120,000 atmospheres caused accidental melt to a small area of a diamond anvil press. Punch-Jones 34.46 octahedron, found 1928 in West Virginia, sold by Sotheby's. World's largest known uncut diamond displayed at Smithsonian; at 890 ct some think it may cut a larger stone that the Cullinan I (530.20 ct). U.S.S.R. claim to have produced a 2 kilogram synthetic diamond crystal.

Coloured stones. First-sized Mexican opal with fine play of colour found in Queretaro. Golden danburite from Madagascar, pink zircon from Australia and colourless andalusite from Brazil reported by Spanish Gemmological Association. Moroccan anglesite coloured amber-red by dipping in bleach. Fine emerald crystal of 63.70 ct found at Rainbow End mine in North Carolina, another of 1800 ct was of specimen quality only.

Precious metals. High yield of gold and other metals found on west side of Cook's Inlet, Alaska. Refinery opened in Singapore. Sri Lankan gold is to be hallmarked; India, Hong Kong and Singapore make similar arrangements.

Synthetics. General Electric announce the making of the first synthetic jadeite, high temperatures and pressures in diamond synthesis presses were needed. Green, black or lavender shades possible using chromium or manganese dopants. No commercial production planned. Russian hydrothermal emeralds examined and similarity with Zambian natural stones and overlap of testing constants mean that further investigation is needed.

Announcements. Largest faceted diamond currently on display in U.S. is the Ashley 102 ct light yellow at Los Angeles County Museum; once part of Czarist Crown Jewels. Tiffany 'Iris' corsage containing 120 Yogo Gulch, Montana, sapphires is on display in Baltimore. Dates of other shows are given.

American Gem Trade Association recommends that gemstone purchasers be made aware that natural stones are processed by a. cutting and polishing, b. heating to permanently change color, c. application of colourless oil, d. bleaching, e. non-detectable irradiation to permanently change color. It is not acceptable to offer for sale, without full disclosure, gemstones subjected to f. dyeing, tinting, laser drilling, g. irradiation or heating where colour change is not permanent, h. impregnation with wax, paraffin, glass plastic or colored oil, j. composite process, overgrowth and surface diffusion. Other treatments will be considered when notified. R.K.M.

KOIVULA (J. I.), FRYER (C. W.). *Identifying gem-quality synthetic diamonds: an update.* Gems Gemol., **XX**, 3, 146–58, 19 figs in colour, 1984.

A paper to quash American rumours that carat sized synthetic diamonds are now available. Three cut stones (largest 0.40 ct) and five crystals (largest 0.735 ct) were re-examined. No other faceted synthetic diamonds are known.

It was shown that these stones differed from natural diamonds in their inclusions, internal strain patterns, fluorescence and phosphorescence, conductivity and magnetic attraction and could therefore be identified positively as synthetic. New methods of manufacture, should they be found, would mean new products and the identification problem would start afresh, but there seems no reason to believe that those products would not be recognizable as man-made. R.K.M.

KOIVULA (J. I.), FRYER (C. W.). *Green opal from East Africa.* Gems & Gemology, **XX**, 4, 226–7, 4 figs in colour, 1984.

An opal with nickeliferous green body colour from Tanzania, looking very like chrysoprase. RI 1.452, SG 2.125. R.K.M.

MADIGAN (R.). *Diamond exploration in Australia.* Indiaqua, 35, 27–38, 47 figs (46 in colour), 1983.

A history of the discovery and production of diamond in Australia. M.O'D.

MANSON (D. V.), STOCKTON (C. M.). *Pyrope-spessartine garnets with unusual color behaviour.* Gems & Gemology, **XX**, 4, 200–7, 6 figs (4 in colour), 1984.

A further contribution from the research into garnets by these authors deals with 32 stones which showed 'alexandritic' changes of colour under different light sources. [The regrettably misleading trade name 'Malaya' is used.] R.K.M.

MERTENS (R.). *Hauyn, ein seltener Edelstein.* (Hauÿne, a rare gemstone.) Z.Dt.Gemmol.Ges., **33**, 1/2, 65–7, 4 figs in colour, bibl., 1984.

Hauÿne is a beautiful blue gemstone found in pumice in the volcanic Eifel near the lake of Laach. Most crystals are tiny, pea-size crystals being a rarity, but all of a beautiful blue. They are silicates of a complicated composition, cubic, mostly found as cubes or rhombic dodecahedra, but well crystallized finds are rare. RI 1.502, SG 2.40. Hauÿne is a constituent of lapis lazuli. E.S.

NEUMANN (E.), SCHMETZER (K.). *Farbe, Farbursache und Mechanismen der Farbumwandlung von Amethyst. (Colour, cause of colour and mechanism of colour change in amethyst.) Z.Dt.Gemmol.Ges.*, **33**, 1/2, 35–42, 1984.

The colour in amethyst is caused by Fe^{4+} colour centres incorporated substitutionally on tetrahedral Si^{4+} sites of the quartz structure. Colourless quartz with Fe^{3+} is converted to violet amethyst by ionizing radiation developing Fe^{4+} and Fe^{2+} centres. Both iron centres of amethyst are simultaneously converted by heat treatment to yellow and green colour centres. When citrine is heat treated, the iron centres of amethyst are predominantly converted to iron-containing particles. The mechanism of thermal conversion of colour and colour centres by heat treatment of amethyst is discussed. E.S.

NIXON (P. H.). *The prospect of diamonds in the South-West Pacific.* Indiaqua, 28, 11–16, 25 figs (18 in colour), 1981.

Areas with low temperature gradients at the time of eruption are considered likely sources for primary diamond deposits. The south-west Pacific area is being prospected as being worth investigation. M.O'D.

O'DONOGHUE (M.). *Kashmir sapphires.* Art at Auction, 1983/84, 342–4, 2 figs in colour, 1984.

Some Kashmir sapphires have been seen at Sotheby's during the year under review. This short summary of the occurrence and properties of the sapphires is illustrated by two stones, both fetching well into six figures. (Author's abstract.) M.O'D.

POPKOVA (T. N.). (Microhardness of some amber-like fossil resins.) Zap.Vses. Min.Obshch., **113**, 128–33, 5 figs, 1984. [In Russian.]

The microhardness of amber-like resins from the U.S.S.R. (Sakhalin, Taimyer Island and the Pal'mniken Cape) and France was measured by a diamond pyramid indenter with automatic loading at a load time of 30s. The average values for viscous resins were: rumanite 27.4 – 35.5 and succinite 19.7 – 28.1 N/mm^2. The brittle resins gave: allingite 28.5 – 30.5, plaffeyite 27.4 – 22.6, gedanite 25.2 – 30.1, retinite 23.0 – 24.9 and amber-like retinite 26.1 – 29.6 N/mm^2. With increasing O in the viscous resins the structural bonds weaken, H decreases and brittleness increases whereas in the brittle resins H increases and elasticity improves. R.A.H.

PUNCHIAPPUHAMY (T. G.). *Well known gems of Sri Lanka.* J. Gemmologists Association of Sri Lanka, 1, 17–20, 1984.

There is great potential for exploration of '*in situ*' deposits of gemstones in Sri Lanka, since so far mining has been largely confined to alluvial mining in river beds and flood plains. Varieties of gemstones found in Sri Lanka are listed, and some of the well known Sri Lanka gems displayed in museums in U.S.A. and U.K. and held by the State Gem Corporation are listed and described. J.R.H.C.

PUNCHIHEWA (L. J.). *The Gem Trade Laboratory Quality Grading System for Sri Lanka gemstones.* J. Gemmologists Association of Sri Lanka, 1, 21–30, 1 fig. in colour, 1984.

The GTL Quality Grading System based on three primary scales of assessment – (a) Colour Grading Scale, (b) Perfection Grading Scale and (c) Perfection Grading Scale for Phenomenal Gemstones (Star-stones, Cat's eye, Alexandrite) – is described in detail. J.R.H.C.

RECKER (K.). *Synthetische Diamanten.* (Synthetic diamonds.) Z.Dt.Gemmol.Ges., **33**, 1/2, 5–34, 21 figs, bibl., 1984.

A progress report on diamond synthesis methods, including the catalyst-solvent process, direct graphite to diamond transformation, diamond growth under metastable conditions, growth of larger crystals. Some of the properties of synthetic diamond are listed, and the historical development of diamond synthesis experiments given. The author believes that larger synthetic diamonds will soon be on the market, which up to now have not been economically viable. E.S.

ROSSMAN (G.), KIRSCHVINK (J. L.). *Magnetic properties of gem-quality synthetic diamonds.* Gems Gemmol., **XX**, 3, 163–6, 1 fig. in colour, 1984.

A further investigation of the four larger stones discussed by Koivula and Fryer (see above), together with industrial diamond powders from G.E.C. and from P.R. of China. Natural stones and irradiated natural stones were also examined. Synthetic stones were more magnetic. Cut natural diamonds were magnetic initially but cleaning in hot hydrochloric acid removed traces of scaif iron from the polished surfaces and they became markedly less magnetic. There are fundamental differences in the magnetic properties of synthetic and natural diamonds which could be the basis of a distinguishing test. R.K.M.

RUPASINGHE (M. S.). *Radioactive gem minerals from Sri Lanka.* J. Gemmologists Association of Sri Lanka, 1, 5–12, 3 figs, 3 tables, bibl., 1984.

A new radioactive monazite crystal found in Sri Lanka was studied for its rare element chemistry. Differently coloured zircons were analysed and their chemical differences and similarities noted. Th and U were high in the monazite. J.R.H.C.

SAKUNTALA (S.), KRISHNA BRAHMAM (N.). *Diamond mines near Raichur.* J. Geological Soc. of India, **25**, 12, 780–6, 1 map, 1984.

Information relating to diamond mining in the Raichur area of Karnataka State, India, in the fifteenth century is critically analysed. The localities of Alibenchi and Nelaha, near Raichur, are identified. The 'Raichur diamond' in the museum of the Directorate of Mines and Geology (Govt of Andhra Pradesh) is a colourless octahedral crystal of 2.57 ct. A detailed search for kimberlite pipes is suggested. R.A.H.

SALEH (Z. A.). *Growth of the Gemmologists Association of Sri Lanka.* J. Gemmologists Association of Sri Lanka, 1, 38–40, 1984.

Traces the history of the Gemmologists Association of Sri Lanka from its foundation in 1970 under the Presidency of the late Professor K. Kularatnam to the first issue of its Journal in October 1984. J.R.H.C.

SARBAS (B.), GOERG (U.), AMSTUTZ (G. C.), SCHMETZER (K.), BANK (H.). *Zur Genese ostafrikanischer Grossularvorkommen.* (The genesis of East African grossular occurrences.) Z.Dt.Gemmol.Ges., **33**, 1/2, 48–62, 7 figs (6 in colour), bibl., 1984.

Grossularite and zoisite occurrences in Lualenyi and Mangari, Kenya, and Komolo and Merelani, Tanzania, were investigated petrographically and geochemically. Both gem minerals show green and blue-violet colours, caused by vanadium (0.68–3.3% in grossularite, 0.12% in zoisite). They occur in graphite schists, consisting mainly of quartz, potassium-feldspar, graphite with plagioclase, kyanite, micas, scapolite, diopside, epidote or allanite. A polymetamorphic history is supposed.

E.S.

SAUL (J. M.). *Deposits of coloured gemstones: their distribution in time and space.* J. Gemmologists Association of Sri Lanka, 1, 13–16, 2 maps, 1984.

Coloured gemstones occur in characteristic patterns in regions of metamorphosed sediments alongside deep, thin, long-lived zones of high heat-flow, as observable for gem localities in Brazil, Western Africa, Zimbabwe, Zambia, Mozambique, Tanzania, Kenya, Madagascar, South-western India and Sri Lanka, all parts of pre-drift Gondwanaland, where gem deposits are associated with rift valleys or spreading of continental plates.

Other groups of deposits are in the Urals, the region where U.S.S.R./Pakistan/Afghanistan/Kashmir come together, eastern Nepal, Burma and Thailand/Cambodia/Vietnam; these are on the Asian 'mainland' (N. and E.) side of suture lines, continent-continent collision zones and zones of oceanic subduction, which are not identical to rifts, and proximity would not imply the same heat flow, so a fuller understanding of them will depend on additional geological factors.

Similar reasoning can account for deposts in Australia, North America, Europe, and Asia south-east of Lake Baikal.

Emerald deposits appear to have developed in cooler times or niches within the gemstone regions with greater separation from zones of heat flow. J.R.H.C.

SCARRATT (K.). *How to recognise the new Seiko synthetics.* Retail Jeweller, **22**, 569, 16/26, 7 figs in colour, 1984.

The new Seiko synthetics, made by Matsushiwa Kogyo Co. Ltd, an affiliated company of Suwa Seikosha, who also produce quartz crystals for Seiko watches, include synthetic alexandrite, ruby and sapphire by the 'floating zone' method (the crystals being similar in shape to Verneuil boules) and synthetic emerald (flux-fusion), and at present are marketed only in finished jewellery.

The synthetic alexandrite has a good colour change, and neither it nor the synthetic ruby can be distinguished from natural by RI, SG, fluorescence or absorption spectrum (by hand-spectroscope): the most practical method of identification is by examination of internal features under the microscope, of which many are similar to those of Verneuil synthetics (such as tadpole-like bubbles) but the over-all swirled appearance distinguishes them from the Verneuil type, except that the swirled features may appear similar to the curved lines in the Verneuil synthetic ruby.

The RI and SG of the synthetic orange/pink sapphire are similar to those of the synthetic ruby and their fluorescence and absorption spectrum are similar but weaker; their internal features (curved or swirled growth structures) are visible only when immersed in methylene iodide.

Only one synthetic emerald was available for examination: its RI (1.561–1.565) and SG (2.66) were similar to those of other synthetic emeralds on the market, and its absorption spectrum was similar to that of other synthetic and natural emeralds, but its fluorescence under both long- and short-wave UV was green, unlike any so far seen in either natural or synthetic emeralds. The inclusions, such as two-phase feathers and 'Venetian blinds' zoning, were typical of most synthetic emeralds, but viewed without magnification or immersion the stone appeared to have a very dusty surface, the dust particles being in fact within the stone, and if these are common in other samples they should indicate the stone's origin. J.R.H.C.

SCHMETZER (K.). *Pektolith aus der Dominikanischen Republik.* (Pectolite from the Dominican Republic.) Z.Dt.Gemmol.Ges., **33**, 1/2, 63–4, 2 figs in colour, bibl., 1984.

Two rough stones from the Dominican Republic were found to be pectolite. The material is light blue to bluish white, used for cabochons and is known commercially under the name 'Larimar' stone. It is fairly dense (SG 2.74–2.90) and takes a good polish. E.S.

SCHMETZER (K.), BANK (H.). *Zusammensetzung, Eigenschaften und Herkunft eines neuen Hämatitmaterials.* (Composition, properties and origin of a new haematite material.) Z.Dt.Gemmol.Ges., **33**, 1/2, 75–8, 1 fig., bibl., 1984.

An English version of this article was published on pages 343–7 above. E.S.

SCHRADER (H.-W.). *Chromdiopsid aus der UdSSR.* (Chrome diopside from U.S.S.R.) Z.Dt.Gemmol.Ges., **33**, 1/2, 68–71, 2 figs in colour, bibl., 1984.

An English version of this article was published on pages 213–17 above. E.S.

SCHLUSSEL (R.). *Défauts de structure dans les émeraudes naturelles et synthétiques.* (Structural defects in natural and synthetic emeralds.) Revue de Gemmologie, 81, 13–18, 32 figs in colour, 1984.

Crystal and growth structure of a number of emeralds of different origins, both natural and synthetic, are illustrated and discussed together with a table of constants. M.O'D.

SELLSCHOP (J. P. F.). *The gem carbonaceous.* Indiaqua, 26, 95–9, 8 figs (1 in colour), 1980.

Brief form of a paper describing the part played by nuclear physics in diamond studies. M.O'D.

SHIGLEY (J. E.), FOORD (E. E.). *Gem quality red beryl from the Wah-Wah Mountains, Utah.* Gems & Gemology, **XX**, 4, 208–21, 14 figs in colour, 1984.

Described as the rarest of the gem beryls, this red material occurs in small, rather fractured crystals in two of several rhyolite outcrops of this region. RI varies slightly with colour and can be as low as 1.564–1.568 with small birefringence. SG 2.66 to 2.70. No water is present in composition. Manganese is principal cause of colour and well coloured stones have a distinctive absorption spectrum. R.K.M.

SNOW (J.), BROWN (G.). *LED refractometer light sources,* Aust. Gemmol., **15**, 8, 255–7, 4 figs, 1984.

Assessment of two Australian LED 'sodium' light sources, one of three and the other of six components. Both were of limited efficiency owing to broad transmission, and the first was rather under-powered. R.K.M.

SOBOLEV (N. V.). *Siberian diamonds from the earth's mantle.* Indiaqua, 26, 9–15, 18 figs (7 in colour), 1980.

Describes the discovery of diamonds in Siberia with some details of particular features of the stones. M.O'D.

SOBOLEV (N. V.). *What the Siberian diamonds tell us.* Indiaqua, 30, 11–14, 17 figs (7 in colour), 1981.

Inclusions in Siberian diamonds give an indication of the date of formation of the stone. SEM photographs show crystals of various minerals, including garnet and olivine, as inclusions. M.O'D.

SOLANS HUGUET (J.), DOMENECH CASELLAS (M. V.). *Estudio gemologica de la cruz de la Victoria,* (Gemmological study of the cross of Victoria.) Gemologia, **20**, 61/2, 7–17, 6 figs, 1984.

The Cross of Victoria is a jewel in the Cathedral of Oviedo, Spain. Among the stones with which the cross is set are green beryl and quartz. M.O'D.

STACEY (G.). *Almandine,* Wahroongai News, **18**, 10, 23-6, 3 figs, 1984.

A straightforward account of the commonest of the garnets. R.K.M.

STOCKTON (C. M.). *The Chemical distinction of natural and synthetic emeralds.* Gems Gemol., **XX**, 3, 141-5, 1 fig. in colour, 1984.

38 emeralds from 20 localities and 11 synthetics from 6 manufacturers were analysed by electron microprobe for NaO, K_20, MgO, FeO, Al_2O_3, V_2O_3, Cr_2O_3, SiO_2 and Cl, checking by x-ray fluorescence spectrometry. Cl was found in hydrothermal synthetics. Certain trace elements confirmed natural stones.

Ms Stockton envisages future clean synthetics or others controlled to emulate natural emerald more closely, when presently reliable tests may not apply, and has therefore sought chemical differences. Expenses of such testing precludes its use except for important stones when unproven by normal gemmological methods.

R.K.M.

STOCKTON (C. M.), MANSON (D. V.). *'Fine green' demantoids.* Gems Gemol., **XX**, 3, 179, 2 figs (1 in colour), 1984.

A short report on the finest quality of demantoid, which was not available at the time of their earlier report (abstracted on p. 185 above). R.K.M.

SWEANEY (J. L.), LATENDRESSE (J. R.). *Freshwater pearls of North America.* Gems Gemol., **XX**, 3, 125–40, 10 figs in colour, 1984.

Excellent account of pearls produced by freshwater Unio mussels, some over 80 ct in weight and astonishingly beautiful. Spherical pearls rare. Different Unio species vary from 1″ to megalonaias gigantea which can span 12″. Most are long lived and can reach 50 years which accounts for sizes of some pearls. They are often very baroque and wing shapes are common. Colours vary and add charm to the pearl. Pearl culturing is now being carried out by authors in Tennessee, using these bivalves, but water pollution and other problems occur. R.K.M.

THOMAS (A.). *Perspective on Gemmology, Part 1.* South African Gemmologist, 1, 1, 3–6, 1984.

A review of the progress of gemmology up to 1974. A fledgeling in the thirties, it was well established by the fifties. New generation synthetics prompted new techniques for identification. The flux-melt process then coming into commercial use had been pioneered by scientists in the previous century, but industry's demands had been met by the flame-fusion process. After Chatham and Gilson products, loupe and Chelsea filter were no longer sufficient to identify emerald.

Nassau realized the potential for production of new gem materials of the developments in the sixties of solid state physics. By the turn of the decade Zambian emeralds, tanzanites and tsavorites [*sic*] were becoming familiar and the new Czochralski pulling technique was replacing the Verneuil process, and YAG soon superseded strontium titanate as a diamond substitute. J.R.H.C.

WEDLAKE (R. J.). *History of diamond synthesis.* Indiaqua, 24, 23–6, 10 figs (1 in colour), 1980.

The forms of carbon and the history of diamond synthesis are discussed with particular reference to grits. M.O'D.

WILKS (E. M.), WILKS (J.). *The abrasion resistance of brown diamonds.* Industrial Diamond Review, **44**, 2, 82–5, 6 figs, 1984.

Measurements of the abrasion or polish of six brown Type I diamonds show that they have an abrasion resistance appreciably greater than that of white Type I diamonds. It seems probable that this is associated with lattice imperfections revealed by x-ray topography and by the scattering of light in the diamonds. R.A.H.

How Dr Williamson nearly missed finding the Mwadui diamond pipe. Indiaqua, 23, 29–32, 11 figs (2 in colour), 1979.

A brief biographical account of part of the life of Dr John J. Williamson, dealing with his work at Mwadui, Tanzania. M.O'D.

Namaqualand discoveries. Indiaqua, 23, 37–42, 17 figs (2 in colour), 1979.

Describes early prospecting and the first finds of diamond in South-West Africa. Mining scenes are depicted. M.O'D.

'R.J.' study tour to Brazil proves a mine of information. Retail Jeweller, **22**, 569, 6, 1 photo, 1984.

Describes visits to emerald mines (Socoto, in area of Turutiba), lapidary works where mosaics are made from natural gem materials for table-tops, etc., a tourmaline mine called Lavra Golconda, a topaz mine near Rodrigo Silva (about 20 km south-west of Ouro Preto) and the mining methods employed. J.R.H.C.

Synthetic stone. Four Seasons of Jewelry, 54, 30–61, illus. in colour, 1984. [In Japanese.]

A resumé of the present state of synthetic gemstones in Japan. At least two firms are making jewellery set with synthetic stones and quality is very high. M.O'D.

NOTE: during 1984 gemmological literature was increased by the first appearance of two new periodicals – The South African Gemmologist, Vol. 1, No. 1, July 1984, being the official journal of the Gemmological Association of South Africa (Editor, Mr Arthur Thomas, F.G.A., P.O. Box 4216, Johannesburg 2000, S. Africa), and the Journal of the Gemmologists Association of Sri Lanka, No. 1, October 1984 (Editor, Mr E. Gamini Zoysa, F.G.A., Professional Centre, 275/75 Bauddhaloka Mawatha, Colombo 7, Sri Lanka).

BOOK REVIEWS

BLYTH (F. G. H.), DE FREITAS (M. H.). *A geology for engineers,* 7th edn. Arnold, London, 1984. pp.x, 325. £16.50.

This has always been the best of the 'geology for other specialists' books, and this seventh edition incorporates some new features which should help the non-specialist reader to get to grips with the rather large amount of material that it contains. The structure of the book is different from that of previous editions in that it is now divided into two parts, one dealing with fundamental aspects of earth geology and the other the influence of geology upon engineering.

The illustrations have been updated and most are line drawings. Chapters on rocks, minerals and geological maps have been re-worked to provide a basis for independent work on the part of students; text selection, headings and sub-headings and bibliographies at the end of each chapter are all intended to benefit the student even further and enhance what was already an excellent book.

M.O'D.

FUJISAKI (Y.). *Hoseki chu ken kanbi* (Gemstone inclusions.) Fujisaki, Fukuoka, 1980. pp.178. Illus. in black-and-white and in colour. 25000 yen. (In Japanese.)

Even though the language may deter some readers the standard of the photographs is so high that the book should be carefully examined if encountered. A section on imitation jade is particularly valuable.

M.O'D.

GREENBAUM (W. W.). *The gemstone identifier.* Arco Publishing Co. Inc., New York. pp.viii, 184. Numerous line drawings, 4 plates in colour. $7.95 (soft cover), $13.95 (hard cover).

Apparently intended for the 'uninformed' (American) jeweller and for 'John Q. Public', this is a largely superficial book containing many incorrect and confused statements and adds nothing to gemmology.

It advocates hardness testing; dismisses the refractometer as too expensive; but recommends the Gemoscope, which is far from cheap. Some basic facts and descriptions of gems and testing methods are garbled. Many line drawings are both crude and inadequate; one shows a diamond crystal apparently being *sawn* parallel to the octahedral face with a wood saw. *Synthetic* emeralds are said to contain three-phase inclusions. We are told that all SG liquids other than methylene iodide can be diluted with water. One could quote many other inaccuracies. R.K.M.

HERATH (J. W.). *Mineral resources of Sri Lanka.* 2nd edn. Geological Survey Department, Colombo, 1980. pp.iv, 70. Price on application.

A useful guide containing a short section on gemstone production.

M.O'D.

NASSAU (K.). *The physics and chemistry of color.* John Wiley & Sons, New York, 1984. pp.xx, 454. Illus. in black-and-white and in colour. £45.95.

Apart from its admirable lucidity and wide subject coverage this book will be vital for the serious gemmologist on account of its treatment of gem and mineral coloration. The mechanisms of the 15 different ways in which colour can arise in a substance are closely examined and a number of long-held gemmological suppositions are challenged; one is the cause of colour in blue zoisite (tanzanite); formerly held to be due to vanadium substitution, the colour is here reported to be due to intervalence charge transfer between iron and titanium, as is the case with blue sapphire. This process also gives the blue in benitoite and a brown colour to andalusite. Though gemmologists will turn to their own chapters first all the rest should be read; to ensure that readers have paid sufficient attention to the material, questions, not too searching, are given at the end of each chapter and there are bibliographies at the end of the book, preceded by appendices which treat some of the theories in the body of the book in greater detail. This is an elegant treatment of an elegant subject.

M.O'D.

ROBBINS (M.). *The collector's book of fluorescent minerals.* Van Nostrand Reinhold, New York and London, 1983. pp.xiii, 289. Illus. in black-and-white and in colour. £49.50.

This is a very expensive book, by no means large, and the reader is entitled to expect something rather better than the breathless amateur collector style and hasty presentation that he finds. Virtually all examples are from the United States (this should be stated on the title-page) though a few others have been pushed in at the end of the main descriptive section. The introduction, containing some history of the development of UV lamps, is quite interesting. The descriptive section takes up most of the book, the minerals being arranged chemically. Colour work is attractive, but it is hard to illustrate fluorescing specimens in a way that shows more than a few obvious effects. There is a bibliography, index and some identification tables which are not very helpful, since they merely list yellow fluorescing minerals and so on.

M.O'D.

Ivories of China and the East. Spink & Son Ltd, London, 1984. Unpaged. Illus. in black-and-white and in colour. Price on application.

This is a well-produced sale catalogue and contains details of 294 ivories offered during the period 8th–23rd November, 1984. There is a short bibliography and an introductory note on the nature of ivory.

M.O'D.

The world of Kyocera Crescent Vert. Jewelry New Age, Tokyo, 1984. pp.144. Illus. in colour. 1200 yen.

The book is devoted to a review and illustrations of the Kyocera synthetic ruby, alexandrite, emerald, opal, star ruby and orange 'padparadschah' sapphire.

M.O'D.

ASSOCIATION NOTICES

NEWS OF FELLOWS

Messrs Alan Lam, A.G., F.G.A., and Chris Lam, G.G., F.G.A., are respectively Executive Director and Principal of the newly formed Malaysian Institute of Gemological Sciences (see p. 552).

MEMBERS' MEETINGS

London

On 5th March, 1985, at the Flett Theatre, Geological Museum, Exhibition Road, South Kensington, London, S.W.7., Mr Alec Farn, F.G.A., gave an illustrated talk entitled 'Pearls, the first gems of gemmology'.

Midlands Branch

On 25th January, 1985, at Dr Johnson House, Bull Street, Birmingham, a practical evening was held when members were able to use a wide range of gemmological instruments to examine and test gemstones and crystals.

On 22nd February, 1985, at Dr Johnson House, Major A. K. Crisp Jones gave a talk on 'The Jewellery Quarter and the Arts and Crafts Movement in Birmingham'.

North West Branch

On 17th January, 1985, at Church House, Hanover Street, Liverpool 1, Mr K. Scarratt, F.G.A., gave a talk on the work of the British Gem Testing Laboratory.

On 7th March, 1985, at Church House, Mr D. J. Callaghan, F.G.A., gave a talk entitled 'An Evening with the Gemmological Association'.

On 21st March, 1985, at Church House, Mr C. R. Burch, B.Sc., F.G.S., gave a talk on 'Inclusions in Man-made Gemstones'.

South Yorkshire & District Branch

On 8th February, 1985, at the Montgomery Hotel, Montgomery Road, Sheffield 7, the Annual General Meeting was held at which Mr J. I. Reynolds, F.G.A. and Miss J. I. Platts, F.G.A., were elected Chairman and Secretary respectively. The meeting was followed by a buffet supper.

On 21st March, 1985, at the Sheffield City Polytechnic, Pond Street, Sheffield, Mr D. J. Callaghan, F.G.A., gave an illustrated talk entitled 'From gem to jewel'.

COUNCIL MEETING

At a meeting of Council held on Thursday, 21st February, 1985, at the Royal Automobile Club, London, S.W.1., the business transacted included the following:
(1) on the report of the Chairman that the Basil Anderson Appeal had raised approximately £15000 to date, it was agreed that a list of contributors should be issued in due course;
(2) a request received from the Singapore Gemologist Society for affiliation with the Association was considered and affiliation was granted;
(3) Mr J. R. H. Chisholm having indicated his intention of resigning as Editor of the Journal of Gemmology at the end of 1985 following his 80th birthday and the conclusion of Volume XIX, and at his request, the Council appointed Mr E. A. Jobbins to succeed Mr Chisholm as sole Editor of the Journal and meanwhile to act as Editor jointly with him;
(4) Mr C. R. Cavey was appointed Curator of the Association's collection;
(5) the next meeting of Council was agreed to be held on Tuesday, 28th May, 1985, immediately prior to the Annual General Meeting, at the Flett Theatre, the Geological Museum, Exhibition Road, London, S.W.7.;
(6) the following were elected to membership:

FELLOWSHIP

Barlow, Alice M., Appleton, Wis., U.S.A. 1984
Brown, James E., Sheffield. 1984
Budhwani, Amin M., Bombay, India. 1984
Cahill, Cynthia E., Bangkok, Thailand. 1984
Calduch Sendra, Mª Esmeralda, Barcelona, Spain. 1984
Caracciolo, Marie E., McLean, Va, U.S.A. 1984
Chu, K-C. Quinnie, Don Mills, Ont, Canada. 1984
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The 1985 Reunion of Members and Presentation of Awards is to be held on Monday, 28th October, at Goldsmith's Hall, Foster Lane, London, E.C.2.

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The Malaysian Institute of Gemological Sciences was incorporated last year in Kuala Lumpur to upgrade the standards of the gem and jewellery industry, train professionals and provide service to the public. A gemmological laboratory is maintained and a 'Chartered Gemologist Diploma' (C.G.) will be awarded to students who successfully complete prescribed courses and a research thesis. For further information apply to the Institute at Lot 3.76 – 3.78, 3rd floor, Wisma Stephens, Jalan Raja Chulan, Kuala Lumpur, Malaysia.

REPORTS ON NEW GEM TEST INSTRUMENTS

The 'Gem Instrument Digest', a quarterly publication produced by Peter Read, C.Eng., F.G.A., has reviewed over one hundred items of gem equipment since it was first introduced two years ago.

Further details may be obtained from Peter Read, 68 Forest House, Russell-Cotes Road, Bournemouth, Dorset, BH1 3UB, U.K.

LETTER TO THE EDITOR

From Mr Peter G. Read, C.Eng, M.I.E.E., M.I.E.R.E., F.G.A.

Dear Sir,

With reference to Dr Peter J. Crowcroft's letter in the January 1985 issue of the *Journal,** you may be interested to know that I wrote to Basil Anderson following the publication of Crowcroft's article (on the falsity of the Beilby layer theory) in 1981.† As Anderson was beginning to work on the revision of *Gems* for its 4th edition, and I was in the middle of compiling entries for my *Dictionary of Gemmology*, it seemed germane to ask him whether he was going to modify that section of the book which dealth with the Beilby layer. In his reply to my letter he said that he was present at Imperial College, London, during Professor Finch's confirmatory experiments on the existence of the layer, and did not intend to delete the Beilby layer theory from the book. His view on the matter is summarized in the revised section of the book (page 485) as follows:

'Beilby's contention that in general polishing involved surface flow of the polished material has often been attacked, but the account of his meticulous experiments given in his book *Aggregation and Flow of Solids* (London, 1921) and the later confirmation of his theory by modern methods by G. I. Finch (*Science Progress*, April 1937) are in fact entirely convincing.'

**J. Gemm.*, 1985, XIX (5), 466-7.—Ed.

†*J. Gemm.*, 1981, XVII (7), 459-65.—Ed.

Because of Anderson's strong views on the subject, and despite the circumstantial evidence quoted in Crowcroft's article, I decided to hedge my bets. The Beilby layer entry in my *Dictionary of Gemmology* contains the following statement:
'In 1937 Professor G. I. Finch at Imperial College, London, substantiated and extended Beilby's findings using electron diffraction techniques at grazing incidence to the polished surface. At Diamond Grading Laboratories Ltd, London, R. V. Huddlestone confirmed the existence of the Beilby layer by the use of Nomarski interference contrast techniques. Results of this continuing investigation suggest that the production of the layer is influenced by the lap speed and the difference between the hardness of the material and the abrasive. . . . Despite the evidence, however, strong doubt has been expressed over the existence of the Beilby layer and the validity of the theory.'

It is also of interest to note that in the second edition of his book *Diamonds*, Bruton states (p. 405) that when polishing non-diamond gems 'An experienced lapidary can feel when the surface slips as he is polishing a gem.'

Despite the plethora of scientific papers referred to in Crowcroft's article, the majority of the polishing investigations quoted seem to have been carried out on glass, ceramics and metals. In his conclusion, Crowcroft suggests it is high time that a comprehensive theory of *gemmological* polishing is put forward. Until this happens, and our scientific colleagues produced evidence of the polishing mechanism at work in gem materials, most of us will have to content ourselves with the plausibility of the Beilby layer theory.

Yours etc.,
PETER G. READ

25th March, 1985
Bournemouth, Dorset, U.K.

CORRIGENDA

On p.390 above, in line 10 of the 5th column of Table 1, for '1.672' read '1.762'

On p.412 above, in line 8, for 'or' read 'of', and, in line 10, for 'acicular the crystals' read 'acicular crystals'

On p.439 above, in line 16, for 'darvite' read 'dravite'

On p.445 above, in line 22, for 'studing' read 'studying'

On pp. 456 and 460 above, delete 'Hilton, Barbara W., Riverside, Ca, U.S.A.' and on p. 458 above, before line 1 of 2nd column, and on p. 464 above, after 'Wright, Lee P., Birmingham.' in 2nd column, insert 'Wright-Hilton, Barbara A., Riverside, Ca, U.S.A.

On p.467 above, in line 3 of Corrigenda, for '7/and 8,|' read '7 and 8,' and delete whole of line 9 of Corrigenda.


Gem Testing
B.W.Anderson

Historical Note

The Gemmological Association of Great Britain was originally founded in 1908 as the Education Committee of the National Association of Goldsmiths and reconstituted in 1931 as the Gemmological Association. Its name was extended to Gemmological Association of Great Britain in 1938, and finally in 1944 it was incorporated in that name under the Companies Acts as a company limited by guarantee (registered in England, no. 433063).

Affiliated Associations are the Gemmological Association of Australia, the Canadian Gemmological Association, the Gem and Mineral Society of Zimbabwe, the Gemmological Association of Hong Kong, the Gemmological Association of South Africa and the Singapore Gemologist Society.

The *Journal of Gemmology* was first published by the Association in 1947. It is a quarterly, published in January, April, July, and October each year, and is issued free to Fellows and Members of the Association. Opinions expressed by authors are not necessarily endorsed by the Association.

Notes for Contributors

The Editors are glad to consider original articles shedding new light on subjects of gemmological interest for publication in the *Journal*. Articles are not normally accepted which have already been published elsewhere in English, and an article is accepted only on the understanding that (1) full information as to any previous publication (whether in English or another language) has been given, (2) it is not under consideration for publication elsewhere and (3) it will not be published elsewhere without the consent of the Editors.

Articles published are paid for, and a minimum of 25 prints of individual articles may be supplied to authors provided application is made on or before approval of proofs. Applications for prints should be made to the Secretary of the Association—not to the Editors—and current rates of payment for articles and terms for the supply of prints may be obtained also from the Secretary.

Although not a mandatory requirement, it is most helpful if articles are typed (together with a carbon copy) in double spacing on one side of the paper, with good margins at sides, top and foot of each page. Articles may be of any length, but it should be borne in mind that long articles are more difficult to fit in than short ones: in practice, an article of much more than 10 000 words (unless capable of division into parts or of exceptional importance) is unlikely to be acceptable, while a short note of 400 or 500 words may achieve early publication.

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